119C1 TELEGRAPH SIGNAL DISTORTING SET
DESCRIPTION

CONTENTS PAGE

1. GENERAL

1.01 This section describes and gives the operating principles of the 119C1 telegraph signal distorting set. It is reissued to revise the information on the calibration of the 119C1 set. This section incorporates the information given in the Addendum.

1.02 This equipment generates various types and amounts of signal distortion for use in testing teletypewriter and teletypesetter circuits and apparatus.

1.03 The set operates on type 2 hub signals; that is, the input amplifier requires +60V for the mark and —30V for the space. The set is normally driven from the 110C1 multiple sender, however, optional arrangements are available whereby the input may be switched from the 110C1 multiple sender to a special signal input circuit. Where the special input arrangement is provided, signals other than the standard test sentence may be used to drive the 119C1 set. The special input circuits are so arranged that switching is automatic when connection is made to the SPEC SIGS IN or 119C1 INPUT jack. The set is designed to operate at 60-, 75-, and 100-word speeds in the 5-unit code or at 53-, 66-, and 86-word speeds in the 6-unit code.

1.04 The output signals appear in jacks associated with the test signal supply at No. 2 and No. 9B serviceboards.

1.05 By use of optional output relay circuits the output signals may be converted to polar signals for testing at testboards and TWX testing positions or inverse neutral signals for use at No. 1 serviceboard offices.

1.06 Output signals for various applications are obtained at any appearance of the set by using the appropriate jack, cord, or key. The number of applications for which signals are made available at a particular appearance depends upon the needs at the appearance and the type of control circuit provided.

2. GENERAL FEATURES

(A) Signal Distortion Generating Unit

2.01 The signal distortion generating unit is completely electronic and includes the input hub potentiometer, the input and output amplifiers, the input and output electronic switches, the transition delaying circuit, the detector, the character timing and counting circuits, and the

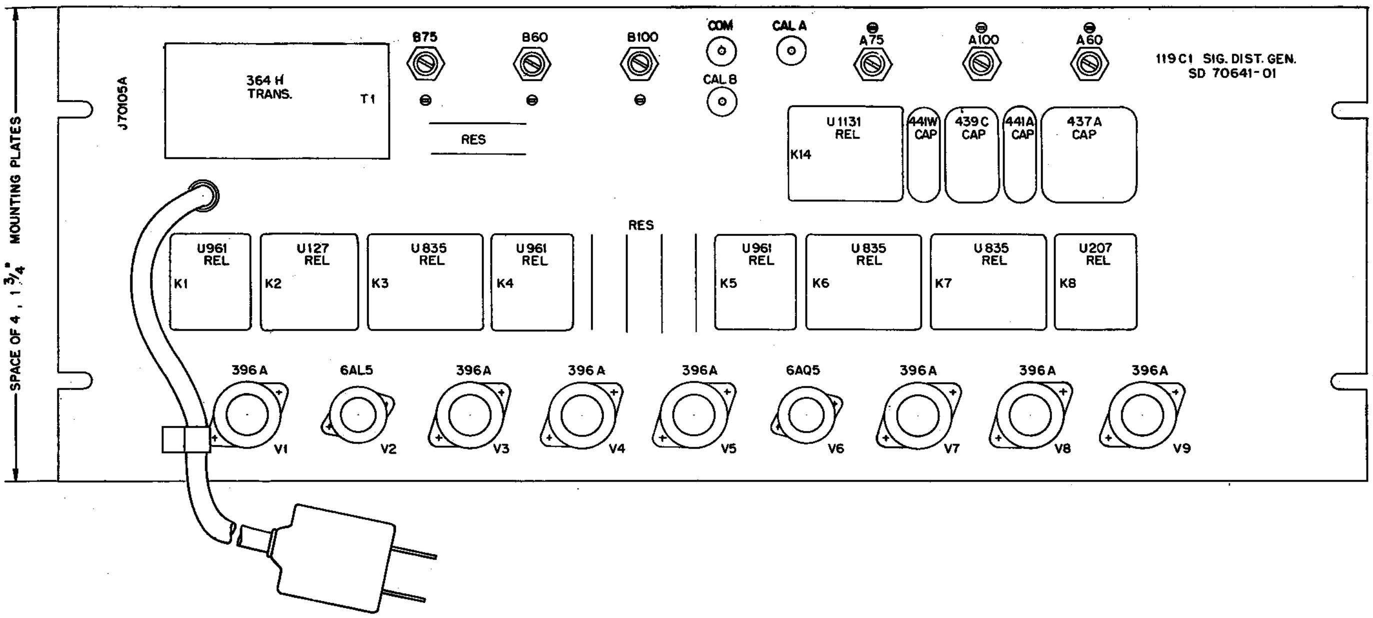


Fig. 1—Signal Distortion Generating Unit—Front View with Cover Removed

calibrating circuits. Fig. 1 is a front view of the generating unit with cover removed and Fig. 2 is a block diagram of the generating unit.

(B) Output Relay Circuit

2.02 This circuit converts the output of the generating unit to polar signals. Switching relays are provided so that the polar signals may be ±130V or ±48V with regular or reversed polarity. By terminating the relay circuit output in battery, effective polar signals are made available.

2.03 An optional output relay circuit is available for No. 1 serviceboard offices. This circuit provides an arrangement whereby inverse neutral signals are made available when connection is made at the No. 1 serviceboard. When connection is made at an appearance other than at the serviceboard, polar signals are made available as discussed in Paragraph 2.02. This circuit is discussed more fully in a later paragraph.

2.04 The output relay circuit may be extended to a testboard or miscellaneous appearance circuit, a test signal supply circuit at a No. 1 serviceboard, a TWX signal supply circuit, a TWX concentrating unit or to appropriate combinations of these.

(C) Control Panel Equipment

2.05 The type and number of control panels provided in an office depends upon individual office arrangements and requirements. The several types of control panels available are shown and described in Fig. 3 and the accompanying notes.

No. 2 Serviceboard Office

2.06 The control switches and keys are installed as a part of the keyshelf equipment in the No. 2 serviceboard. The controls shown in Fig. 4 perform the same functions as the control panel used with the No. 9B serviceboard shown in Fig. 3(A). Where polar signals are required in a No. 2 serviceboard office additional signal distorting sets, together with the appropriate relay and control equipment, are provided for that purpose.

No. 1 Serviceboard Office

2.07 Control panel equipment as shown in Fig. 3(A) is provided for No. 1 serviceboard offices.

TWX Concentrating Unit Test Circuit

2.08 Keys are provided in the concentrating unit test circuit for selecting the various types of switched distortion.

(D) Test Signal Supply

No. 2 or 9B Serviceboard Office

2.09 The test signal supply circuit provides for connecting the output of the signal distorting set to the appropriate SIG jack at the serviceboard. The SIG jack may be patched, using the test signal cord circuit or the teletypewriter cord and set circuit, to the leg jack of a line or loop facility or a regenerative repeater.

No. 1 Serviceboard Office

2.10 The output of the signal distorting set appears as an inverse neutral signal at the 119C1 SIGS jack in the serviceboard. The 119C1 SIGS jack may be patched, using the SIG T cords to send test signals to a line or loop facility or to a regenerative repeater.

(E) Bias Supply

2.11 The signal distortion generating unit requires a source of negative 330-volt supply. At offices where this supply is already available the existing supply may be used. Where the negative 330-volt supply is provided exclusively for testing equipment the minimum requirement is a 330-volt rectifier per J70104B.

(F) Types of Distortion Generated

2.12 The 119C1 set generates ***steady marking*** bias, ***steady spacing*** bias, ***switched*** bias, ***switched*** end-distortion, and ***switched*** combination distortion. The amount of distortion is variable in one per cent steps from zero to 49 per cent under the control of selector switches S1 and S2 in the control panel. The switch settings apply for all types of distortion.

2.13 For convenience and ease in understanding the circuit descriptions that follow, the various types of distortion generated in the 119C1 set are illustrated in Fig. 5. The word "back" used in the illustration is taken from the standard test sentence. It contains four transitions per character, representing the average for miscellaneous signals; and four characters are required to complete the cycle for switched combination distortion as will be seen in the illustration.

2.14 The graphs of Fig. 5 designated (b), (c), (d), (e), and (f) represent the transition displacements in the signal distorting set to produce 40 per cent distortion. Graphs (bb), (cc), (dd), (ee), and (ff) represent the transition displacements as interpreted by the teletypewriter or other start-stop apparatus.

3. CIRCUIT DESCRIPTION

3.01 A schematic drawing of the 119C1 telegraph signal distorting set is shown in Fig. 12 at the back of this section. It is arranged as a fold-out for convenient reference as desired. A table associated with Fig. 12 gives the functions of the switching relays in the generating unit.

(A) Signal Distortion Generating Unit

3.02 In the description of the generating unit that follows, only the circuit conditions for generating marking and spacing bias are discussed. Marking and spacing bias are generated by arranging the circuit to hold the MD and SD control leads at fixed potentials. Other types of distortion are generated by automatically reversing the voltages on the MD and SD control leads at the proper time with respect to the coded characters. For these reasons, and for simplicity of description, the MD and SD control lead polarities are shown in the figures as necessary to describe the generating unit functions. The manner in which these voltages are derived, and the manner in which they are switched to produce all types of switched distortion, is covered under the description of the timing and counting circuits. The generating unit functions in the same manner for both 5-unit and 6-unit code signals, except for a minor function of the character timing circuit which is described later.

3.03 To further simplify the description, a teletypewriter F signal is traced in its progress through the various stages of the generating unit. To facilitate the selecting, switching, and delaying actions in the generating unit the signal polarity is inverted in some stages and converted back to normal in succeeding stages. The signal polarity must, therefore, be considered in each stage of the generating unit in order to understand its principles of operation.

Type and Function of Electron Tubes in Generating Unit

Tube	Type	Function
V1	396A	Squares up wave shape of input signals. Amplifies input signals. Furnishes two sources of signals (one in phase and one out of phase) to the input switch.
V2	6AL5	Selects signals of the correct polarity for presentation to the delay tube.
V3	396A	Delays all space-to-mark transitions appearing in the plate (4) circuit, except when the set is arranged for zero distortion. Inverts all signals.
V4	396A	Amplifies the voltage swings delivered by the delay tube. Squares up the wave shape of distorted signals. Furnishes signals of both polarities on its respective plates to the output switch (V5).
V5	396A	Selects signals of the correct polarity for the timing circuit (V7) and the output amplifier (V6). Inverts all signals.
V6	6AQ5	Produces drive of the correct magnitude for operation of a type 2 hub circuit or output relay circuit.
V7	396A	Identifies the start and stop pulses in the coded characters. Produces a negative going transition on plate 4 at the beginning of every start pulse. Produces a negative going transition on plate 6 near the middle of every stop pulse.
V8	396A	Reverses the polarity of the MD and SD control leads near the middle of every stop pulse when the set is arranged for switched bias. Reverses the polarity of the MD and SD control leads at the beginning of every start pulse when the set is arranged for switched end-distortion. Holds the MD control lead positive and the SD control lead negative when the set is arranged for marking bias. Furnishes a negative pip to V9 grids on every second start pulse.
V9	396A	Reverses the polarity of the MD and SD control leads at the beginning of every second start pulse when the set is arranged for switched combination distortion. Holds the SD control lead positive and the MD control lead negative when the set is arranged for spacing bias.

Note: For a circuit schematic of Fig. 2, see Fig. 12.

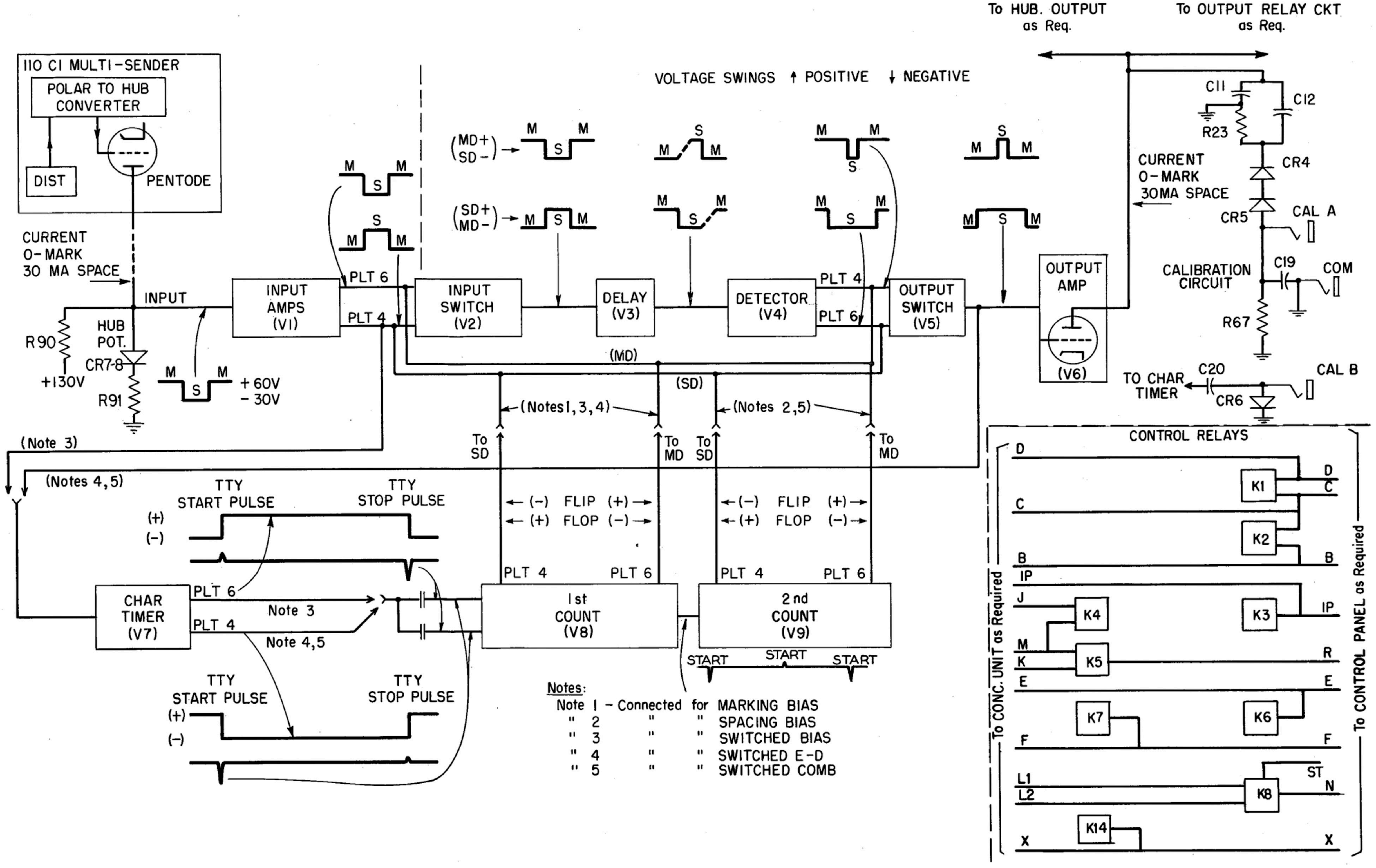


Fig. 2

Fig. 3 (A) Circuit schematic shown in Fig. 12 (A)

Fig. 3 (B) Circuit schematic shown in Fig. 12 (A) and 12 (C)

Fig. 3 (C) Circuit schematic shown in Fig. 12 (C)

Function of Switches, Keys and Jacks Shown in Fig. 3

Switch, Key or Jack	Function Controlled or Application
S1-S2 (Selector Switch)	Selects the amount of distortion (all types) and the calibration circuit.
S3-S4 (Lever Key)	Selects the type of distortion.
S5 (Lever Key)	Selects the signaling speed.
S6 (Lever Key)	Selects the code (5- or 6-unit).
S7 (552 Key)	Controls three conditions of the output relay circuit (1) steady mark, (2) automatic signals, and (3) steady space.
S8 (552 Key)	Controls polarity of signals from the output relay circuit. In the −M position signals are obtained with negative battery for a mark. In the +M position signals are obtained with positive battery for a mark.
J1 (Jack) REG BIAS SIG	Provides access to the polar signal output of the output relay circuit through the ADJ LP CUR potentiometer and grounds the control leads to the output relay circuit.
J2 (Jack) TWX BIAS SIG	Provides access to the polar signal output of the output relay circuit ahead of the ADJ LP CUR potentiometer and grounds the control leads to the output relay circuit. Lamp (L1) provides visual indication if the 119C1 set is in use at another position.

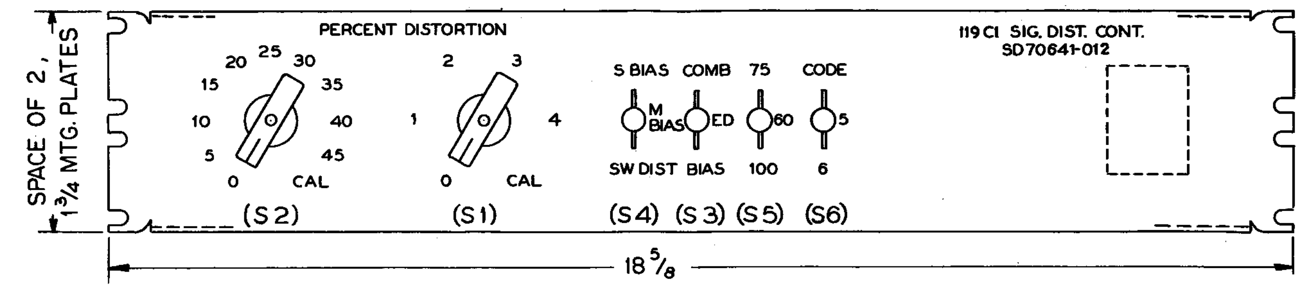
Notes:

The control equipment for a No. 2 serviceboard shown in Fig. 4 is the same circuit arrangement as Fig. 3 (A).

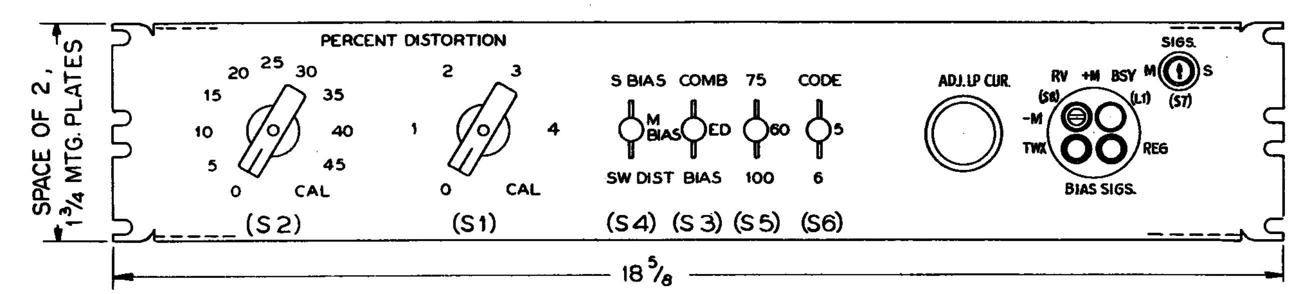
Control equipment per Fig. 3A, 3B or Fig. 4 must be provided with each 119C1 set and must be located within 15 wire feet of the generating unit.

Control equipment per Fig. 3C may be provided at more distant appearances to supplement Fig. 3B. Also, the jack appearances of Fig. 3B may be extended to other locations in accordance with the example shown in Fig. 12 (E).

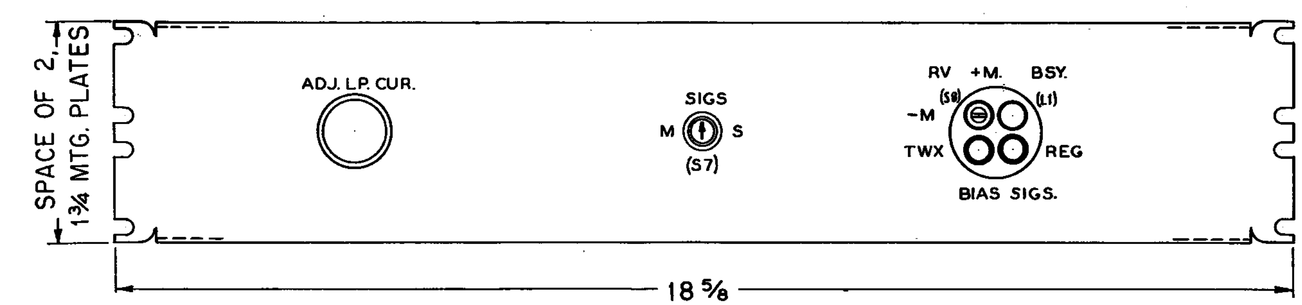
Polar signals for TWX testing in a serviceboard office may be provided in accordance with the example shown in Fig. 12 (F).



(A)—No. 9B Service Board



(B)—Testboard



(C)—Miscellaneous Appearance

Fig. 3—Examples of Control Panel Equipment

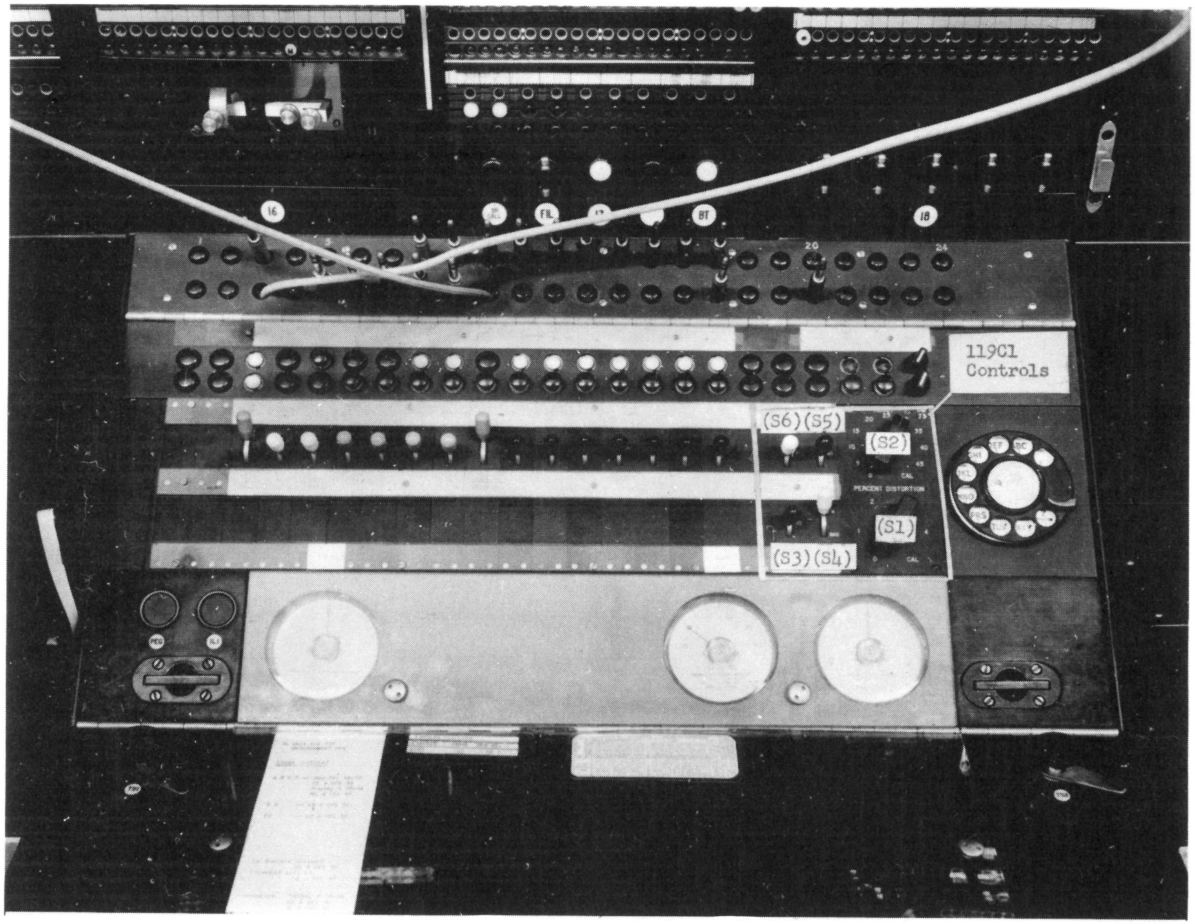


Fig. 4—Control Equipment in No. 2 Serviceboard

3.04 For the purpose of this section, it should be understood that the signal is of normal polarity when the voltage swings are ***positive*** for a ***marking*** element and ***negative*** for a ***spacing*** element; and that the signal is inverted when the voltage swings are ***positive*** for a ***spacing*** element and ***negative*** for a ***marking*** element. The wave forms associated with the various figures used in the description are appropriately designated to show this distinction. The terms ***positive*** and ***negative*** as used in this definition are, in some cases, relative and should not be treated as polarities with respect to ground potential.

3.05 The input signals to drive the generating unit are applied from the 110C1 multiple sender, over the input lead, to the hub potentiometer. When the input signal is a mark, the 110C1 multiple sender draws no current from the hub potentiometer. With no current drawn from the hub potentiometer, the hub voltage applied to grid 3 of V1 is the +60V marking potential. When the input signal is a space, the 110C1 multiple sender draws current of 30 milliamperes from the hub potentiometer. This current drawn from the hub potentiometer drops the hub voltage applied to grid 3 of V1 to the −30V spacing potential. Thus, the voltage swings on grid 3 of V1 are of normal polarity. Refer to Fig. 6(A).

Input Amplifiers

3.06 Tube V1 is a twin triode utilizing the left section for amplifier 1 and the right section for amplifier 2. The input circuit performs the same functions regardless of the type or amount of distortion generated.

Symbols: Marking signal element Spacing signal element

x—Ideal mark-to-space transition point (for no distortion)

y—Ideal space-to-mark transition point (for no distortion)

→(b)—Indicates switching to condition (b)

→(c)—Indicates switching to condition (c)

(a)—Undistorted miscellaneous teletypewriter signals containing 4 transitions each (BACK), representing the signals at the input of the signal distorting set

(b)—Signals of (a) with mark-to-space transitions delayed 40% of a unit interval as they appear in the output of the signal distorting set—to produce 40% marking bias

(c)—Signals of (a) with space-to-mark transitions delayed 40% of a unit interval as they appear in the output of the signal distorting set—to produce 40% spacing bias

(d)—Signals of (a) switched alternately to (b) and (c) during every stop pulse, as shown by indicating arrows—to produce 40% switched bias

(e)—Signals of (a) switched alternately to (b) and (c) during every start pulse, as shown by indicating arrows—to produce 40% switched end-distortion

(f)—Signals of (a) switched alternately to (b) and (c) during every other start pulse, as shown by indicating arrows—to produce 40% switched combination distortion

Graphs (bb), (cc), (dd), (ee) and (ff) represent the signals of (b), (c), (d), (e) and (f) respectively as they are interpreted by a teletypewriter or other start-stop apparatus. The effect upon start-stop apparatus is further demonstrated by Table A

Table A

Teletypewriter Character	B	A	C	K
(bb)	Marking Bias	Marking Bias	Marking Bias	Marking Bias
(cc)	Spacing Bias	Spacing Bias	Spacing Bias	Spacing Bias
(dd)	Marking Bias	Spacing Bias	Marking Bias	Spacing Bias
(ee)	Marking E-D	Spacing E-D	Marking E-D	Spacing E-D
(ff)	Marking E-D	Marking Bias	Spacing E-D	Spacing Bias

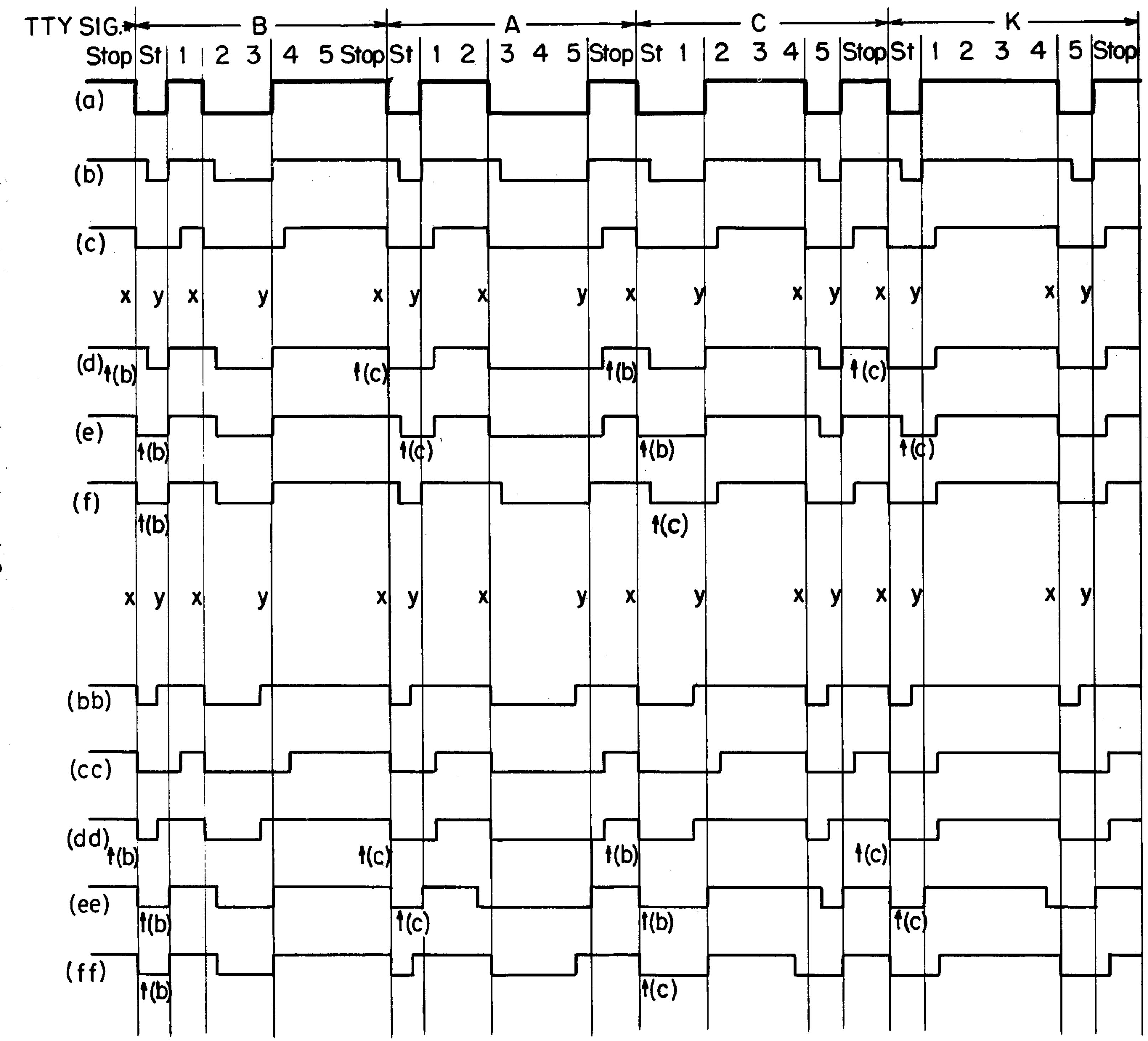
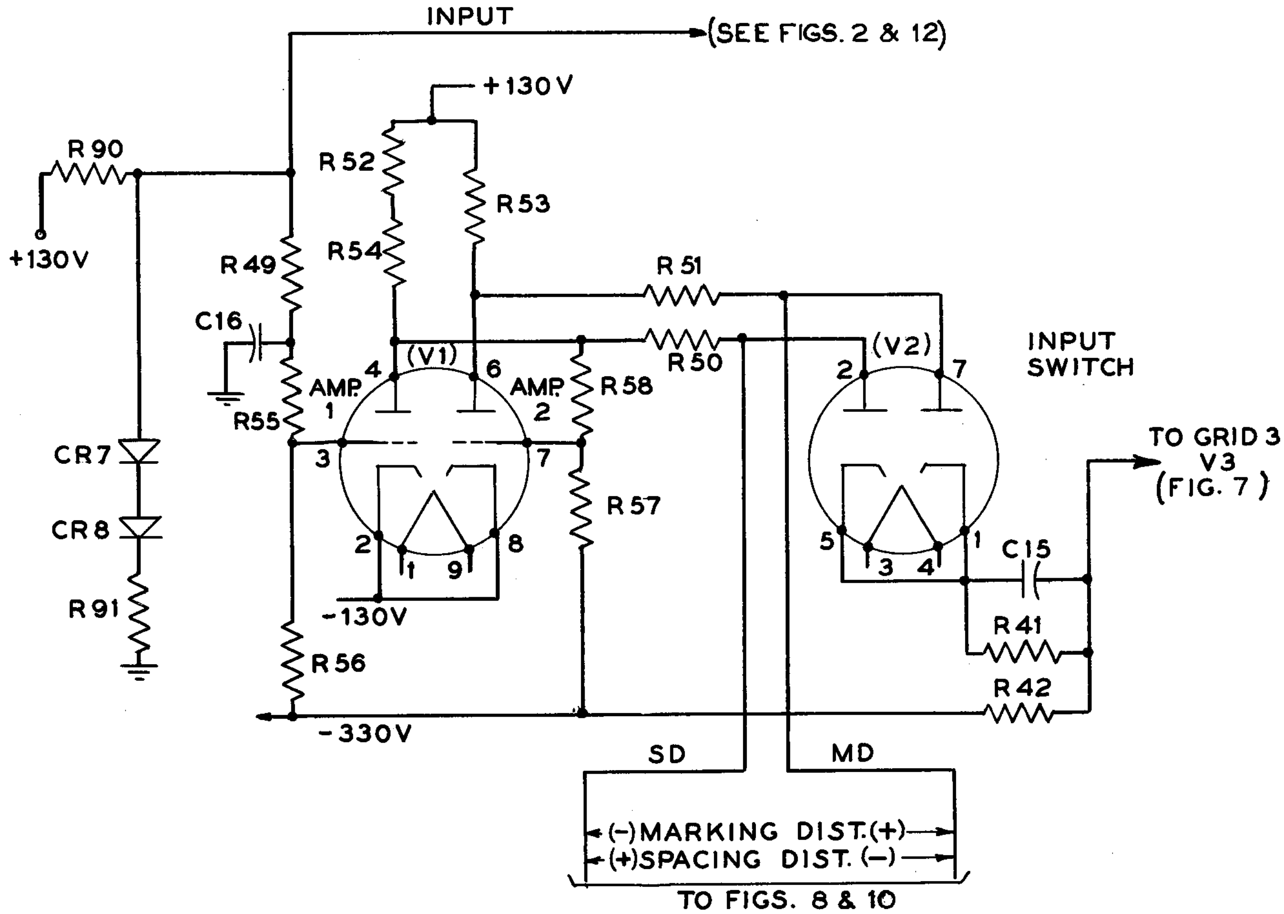
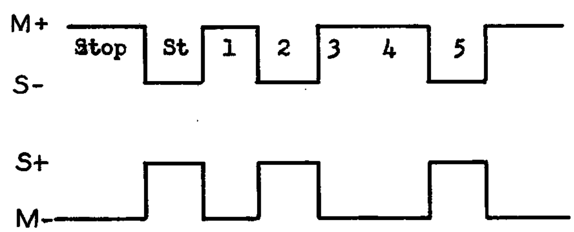


Fig. 5—Examples of Distortion





(A) Voltage on grid 3 and plt 6 (V1) in all cases. Voltage on output of V2 for marking dist.

(B) Voltage on grid 7 and plt 4 (V1) in all cases. Voltage on output of V2 for spacing dist.

Fig. 6—Input Amplifiers and Input Switch

3.07 The input signal wave form of an undistorted teletypewriter F signal is shown in Fig. 6(A). Although the signal from the 110C1 multiple sender and hub potentiometer may not be a perfectly formed square wave as shown, limiting action in the left triode of V1 tends to square up the wave shape.

3.08 The purpose of the input circuit is to amplify the voltage swings applied to the input and to generate one voltage wave in phase with the input signal and another voltage wave inverted with respect to the input signal.

3.09 When the input signal is a ***marking*** element grid 3 of V1 is ***positive*** and the left triode conducts. When the left triode conducts plate current flows through load resistors R52 and R54 causing a voltage drop on plate 4. This voltage drop results in a ***negative*** plate voltage swing corresponding to a ***positive*** signal on the grid.

3.10 When the input signal is a ***spacing*** element grid 3 of V1 is ***negative*** and the left triode cuts off. When the left triode cuts off plate current ceases to flow and there is no voltage drop in the plate load resistors. This results in a ***positive*** plate voltage swing corresponding to a ***negative*** signal on the grid.

3.11 From the foregoing it may be seen that the voltage swings on plate 4 of V1 are inverted with respect to the voltage swings on grid 3. This inverted signal is applied, (1) through resistor R50 to the 2-5 diode of the input switch (V2), and (2) to the grid circuit of the right triode of V1 (amplifier 2). Refer to Fig. 6(B).

3.12 The right triode of V1 is coupled to the left triode by a connection from plate 4 via resistor R58 to grid 7. Due to this coupling the right triode conducts or is cut off by the voltage swings on plate 4. Since plate 4 is ***negative*** for a marking element and ***positive*** for a spacing element, the right triode conducts when the left triode cuts off and cuts off when the left triode conducts.

3.13 When the input signal (grid 3) is a ***marking*** element grid 7 is ***negative*** and the right triode cuts off. When the right triode cuts off the voltage swing on plate 6 is ***positive*** corresponding to ***positive*** voltage on the input signal.

3.14 When the input signal (grid 3) is a ***spacing*** element grid 7 is ***positive*** and the right triode conducts. When the right triode conducts plate current flows through load resistor R53 causing a voltage drop on plate 6. This voltage drop results in a ***negative*** plate voltage swing corresponding to a ***negative*** voltage on the input signal.

3.15 From the foregoing it may be seen that the voltage swings on plate 6 of V1 are of the same polarity as the input signals on grid 3 of V1. Signals of normal polarity are, therefore, applied through resistor R51 to the 7-1 diode of the input switch (V2). Refer to Fig. 6(A).

Input Switch

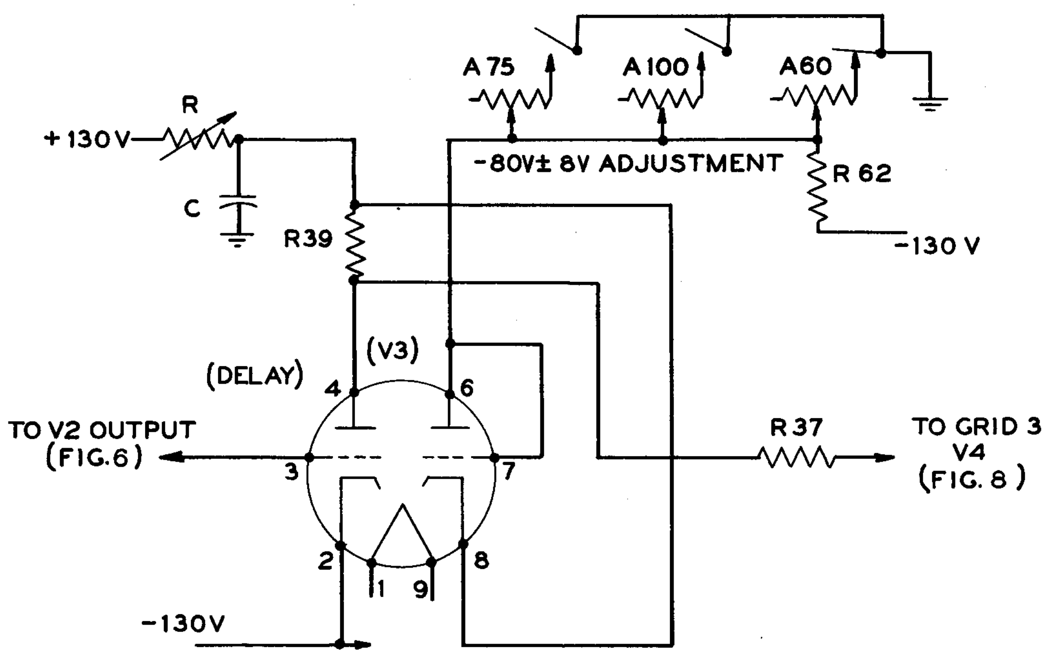
3.16 Tube V2 is a double diode arranged as an electronic switch. While signals are presented to both diodes simultaneously only one diode at a time is permitted to pass the signals as a result of the control voltages on the MD and SD control leads. The main purpose of the input switch is to select the desired signal for presentation to the transition delay circuit.

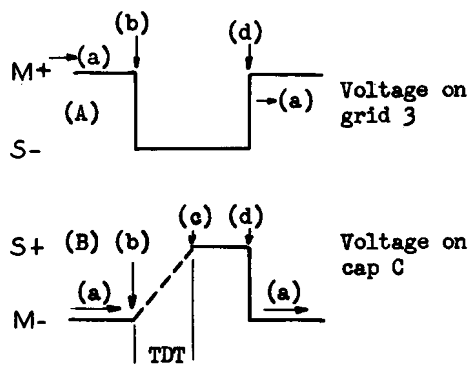
Marking Bias

3.17 Marking bias is generated (in V3) when the MD control lead is positive and the SD control lead is negative. In this condition the 2-5 diode of V2 is blocked by negative voltage from SD. The normal signals from plate 6 of V1 pass from R51 through the 7-1 diode of V2 and are applied to grid 3 of V3. The signal polarity remains normal in this section as shown in Fig. 6(A).

Spacing Bias

3.18 Spacing bias is generated (in V3) when the polarities on the MD and SD control leads are reversed with respect to Paragraph 3.17. In this condition the 7-1 diode of V2 is blocked by negative voltage from MD. The inverted signals from plate 4, of V1, pass from





(a) Positive voltage on grid 3 quickly **charges** C to about -80V and holds it there until a (+) to (-) transition occurs on grid 3

(b) At (+) to (-) transition on grid 3, plate 4 cuts off and C starts charging

(c) C reaches zero

(d) (-) to (+) transition on grid 3 restores condition (a)

TDT represents the transition delay time and the charging time of C

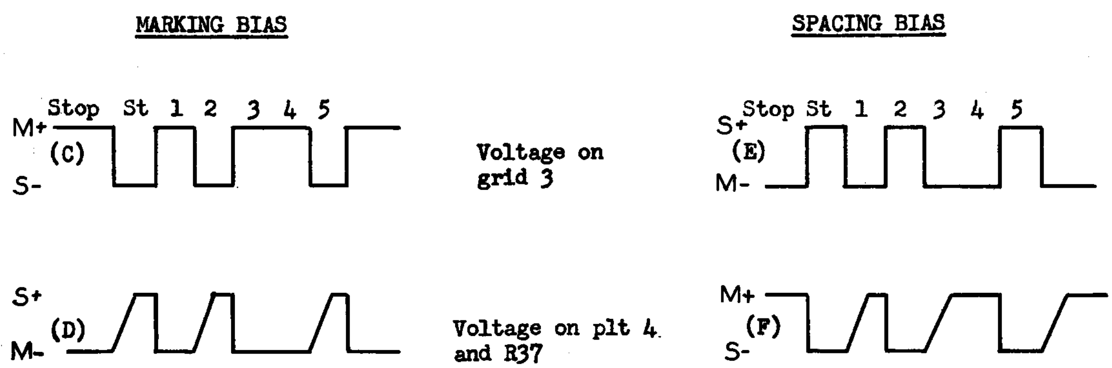
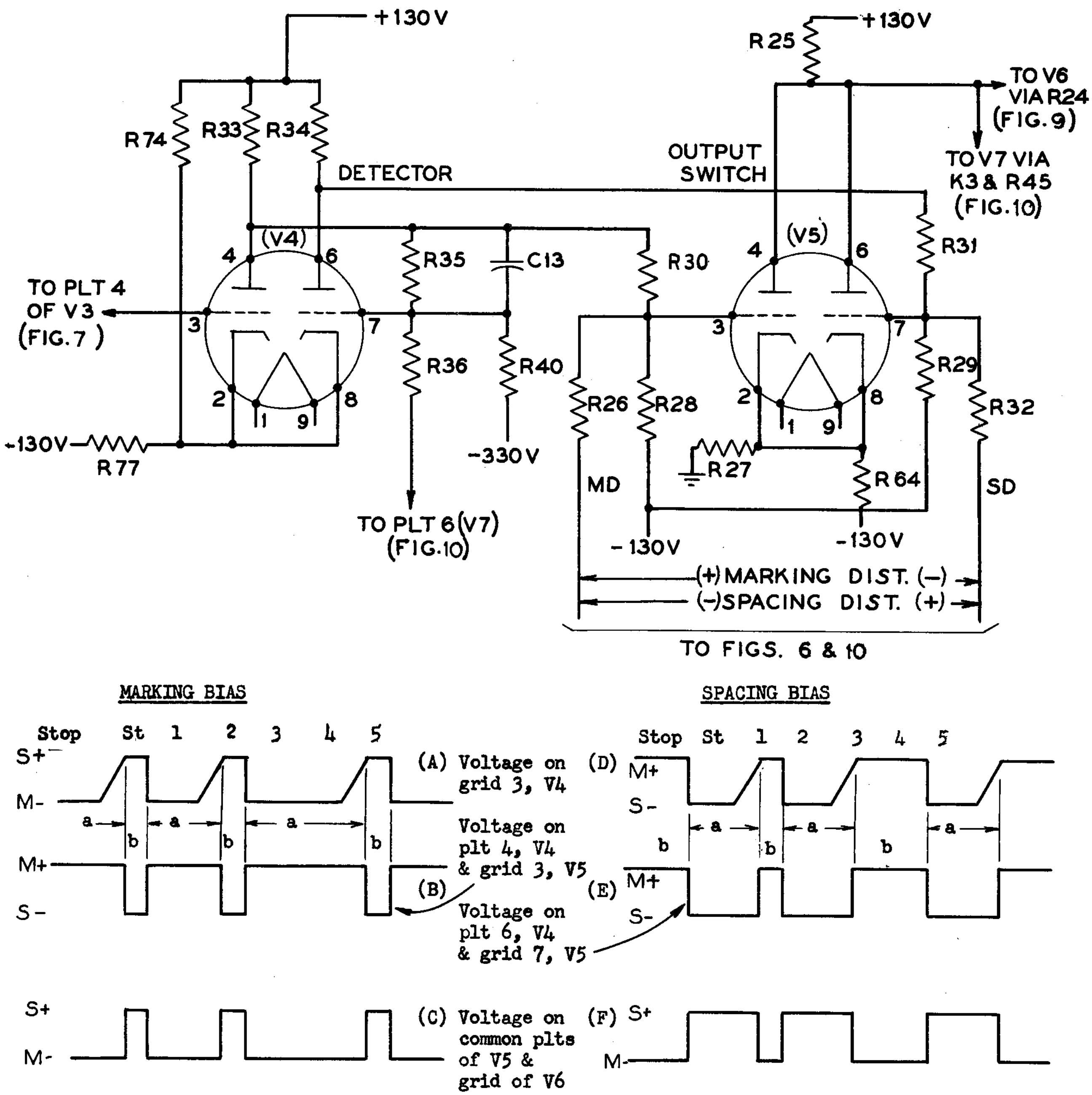


Fig. 7—Transition Delaying Circuit



(a) Left triode (V4) cut off - right triode conducting
(b) Left triode (V4) conducting - right triode cut off

Fig. 8—Detector and Output Switch

R50 through the 2-5 diode of V2 and are applied to grid 3 of V3. The signal polarity remains inverted in this section as shown in Fig. 6(B).

Transition Delay Circuit

3.19 The delay circuit consists of an RC circuit and a discharge tube shown as the left triode of V3 in Fig. 7. The capacitance C, shown in the figure, is of fixed value for each speed of signaling and its value is determined by the setting of the speed key (S5) on the control panel. The resistance R, shown in the figure, is variable under the control of selector switches S1 and S2 on the control panel. The right triode of V3 will be discussed under the subject of calibration and may be assumed at this time to be properly adjusted. Sketches A and B of Fig. 7, with the accompanying notes, briefly describe the action of V3; however, a more detailed description is given in the following paragraphs.

3.20 When a positive signal, whether it be a marking or spacing element, appears on grid 3 of V3 the left triode conducts. With the left triode conducting plate 4 draws current which quickly charges capacitance C to a negative potential (normally about —80V).

3.21 When a negative signal, whether it be a marking or spacing element, appears on grid 3 of V3 the left triode cuts off. With the left triode cut off plate 4 draws no current, and since capacitance C is in a negatively charged condition it will now start charging positively from +130V battery through resistance R. The charging time for capacitance C, therefore, starts when a (+) to (—) transition occurs on grid 3 of V3.

3.22 The time required for capacitance C to build up from its negatively charged state (about —80V) to approximately zero volts is the transition delay time and consequently the transition shift in terms of percentage of a unit interval.

3.23 When the charge on capacitance C reaches approximately zero volts and consequently when the voltage at R37 is approximately zero, the succeeding tube (V4) starts to conduct. This point, therefore, represents the end of the transition delay period.

Marking Bias

3.24 Marking bias is generated (in V3) when the normal signal repeated by the 7-1 diode of V2, shown in Fig. 7(C), is applied to the input of V3. Since V3 inverts all signals the output (of V3) in this case is an inverted signal, as shown in Fig. 7(D), with the space-to-mark transitions delayed. The signals are restored to normal polarity in succeeding stages so that mark-to-space transitions are delayed in the output circuit resulting in marking bias.

Spacing Bias

3.25 Spacing bias is generated (in V3) when the inverted signal repeated by the 2-5 diode of V2, shown in Fig. 7(E), is applied to the input of V3. The output (of V3) in this case is a normal signal, as shown in Fig. 7(F), with the space-to-mark transitions delayed. The signal polarity in the output circuit is the same as the polarity in this stage resulting in spacing bias.

Detector Circuit

3.26 The detector circuit, V4, is a twin triode flip-flop circuit. Plate 4 is coupled to grid 7 through resistor R35 and the cathodes have a common resistance, R77. When one triode conducts it immediately cuts off the other triode. Because of this flip-flop action signals of both polarities (normal and inverted) appear on the respective plates of V4. Due to the control voltages on the MD and SD leads, however, only the signals having the correct polarity are applied to the respective grids of tube V5.

Marking Bias

3.27 When marking bias is generated (in V3) the inverted signals shown in Fig. 8(A) are applied to grid 3 of V4. During the stop element, which is a negative voltage swing on grid 3 of V4, the left triode cuts off and the right triode conducts. At the end of the stop element grid 3 of V4 is held negative because of the negatively charged condition of capacitor C (Fig. 7). Grid 3 of V4 now starts to lose its negative potential as already explained. When the potential on grid 3 of V4 builds up to a voltage of about zero, the left triode of V4 starts conducting and cuts off the right triode. At the end of the start pulse shown in Fig. 8(A) the left triode of V4 again cuts off and the right triode again conducts. This flip-flop action performs two important functions, (1) it squares up the wave shape of the distorted signals, and (2) it converts the signal polarity to normal on plate 4 of V4 as shown in Fig. 8(B). The signals applied via R30 to grid 3 of the output switch (V5) are, therefore, of normal polarity with all mark-to-space transitions delayed. The inverted signals appearing on plate 6 of V4 at this time are of no significance since they are blocked at grid 7 of V5 by negative voltage on the SD control lead.

Spacing Bias

3.28 When spacing bias is generated (in V3) the normal signals shown in Fig. 8(D) are applied to grid 3 of V4. During the stop element, which is a positive signal on grid 3, the left triode of V4 conducts and the right triode cuts off. The signal polarity on plate 6 is, therefore, the same as the signal polarity on grid 3; that is, a signal of normal polarity with space-to-mark transitions delayed. The wave shape is squared up by the trigger action of V4 as in the case of marking bias. The inverted signals appearing at this time on plate 4 of V4 are blocked at grid 3 of V5 by negative voltage on the MD control lead.

3.29 A minor circuit function is performed by the connection between grid 7 of V4 and plate 6 of V7. The connection is used only in the switched bias case (relay K3 operated) to hold the right triode of V4 in the cutoff condition when switching from marking to spacing. If this connection were not provided the right triode of V4 would conduct momentarily near the middle of every second stop pulse, producing signal discontinuity and possibly resulting in a false start in the output circuit. Refer to Fig. 12.

Output Switch

3.30 Tube V5 is a pair of triodes with common plate load resistor, R25. Grid 3 is connected to plate 4 of V4 through resistor R30 and to control lead MD through resistor R26. Grid 7 is connected to plate 6 of V4 through resistor R31 and to control lead SD through resistor R32. The main purpose of the output switch is to select the desired signal for presentation to the output amplifier circuit (V6).

Marking Bias

3.31 When marking bias is generated (in V3) signals of normal polarity are applied to grid 3 of V5 and the MD control lead is positive. At the same time signals are blocked from the right triode due to negative voltage applied to grid 7 from the SD control lead.

3.32 Since signals from plate 4 of V4 are of normal polarity (when generating marking bias) grid 3 of V5 is positive for a marking element and negative for a spacing element. The signals on the common plates of V5 are, therefore, inverted as shown in Fig. 8(C).

Spacing Bias

3.33 When spacing bias is generated (in V3) signals of normal polarity are applied to grid 7 of V5 and the SD control lead is positive. At the same time signals are blocked from the left triode due to negative voltage applied to grid 3 from the MD control lead.

3.34 Since signals from plate 6 of V4 are of normal polarity (when generating spacing bias) grid 7 of V5 is positive for a marking element and negative for a spacing element. The signals on the common plates of V5 are, as in the case for marking bias, inverted as shown in Fig. 8(F).

Output Amplifier

3.35 Tube V6 is a power pentode. The plate circuit may be connected to an externally provided type 2 hub potentiometer in serviceboard offices or to an output relay circuit where polar signals are required. The control grid of V6 is connected via resistor R24 to the common plates of the output switch (V5). Since all signals appearing on the output of V5 are inverted, the grid swing at V6 is positive for spacing elements and negative for marking elements.

Marking Bias

3.36 When marking bias is generated (in V3) the inverted signal shown in Fig. 9(A) is applied to the control grid of V6. With a negative voltage swing (inverted marking element) on the grid of V6, the plate draws no current from the hub potentiometer. With no current drawn from the hub potentiometer, the hub voltage is the +60V marking potential. With a positive voltage swing (inverted spacing element) on the grid of V6, the plate draws current of 30 milliamperes. This current drawn from the hub potentiometer, drops the hub voltage to the —30V spacing potential. Refer to Figs. 9(B) and 9(E).

Spacing Bias

3.37 When spacing bias is generated (in V3) the inverted signal shown in Fig. 9(C) is applied to the control grid of V6. The action is the same as described for marking bias, except for the timing of the marking and spacing elements. Refer to Figs. 9(D) and 9(F).

3.38 The V6 output signals delivered to the output relay circuit are described under the discussion of that circuit.

Character Timing Circuit

3.39 The purpose of the character timing circuit, associated with tube V7, is to maintain synchronism with the incoming or outgoing code characters. This synchronism is necessary in order that switching between marking and spacing distortion may be done at definite points in the coded characters. By switching during the start and stop pulses of the coded characters no unwanted distortion is caused by the switching operations. Under the control of tube V7, all switching for switched bias is performed during the stop intervals, all other switching is performed during the start intervals.

3.40 Tube V7 is connected as a "one-shot" multivibrator. The term "one-shot" is used because tube V7 starts its cycle of operation when the first transition of an inverted start element [(—) to (+) transition] is received on grid 3. After this starting transition is received the signals on grid 3 have no control over the functions of V7 until it times out near the middle of the succeeding stop pulse.

3.41 Tube V7 is coupled from plate 6 to grid 3 via varistors CR-1, —2, —3, and resistor R17. Refer to Fig. 10. Plate 4 is coupled to grid 7 via capacitor C10 and resistor R21. Signals are applied to grid 3 via R45 for the purpose of starting the timing action as described before. When relay K3 is operated (for switched bias) the synchronizing start pulse is applied from plate 4 of V1. When relay K3 is released (for switched end-distortion, or switched combination distortion) the synchronizing start pulse is applied from the common plates of V5.

3.42 During the stopped condition the signal voltage applied via R45 to grid 3 of V7 is negative and the left triode is cut off as shown in Figs. 10(A) and 10(B). The right triode is in the conducting condition due to positive voltage applied from the B calibrating potentiometers via resistors R19 and R20 to grid 7. With the right triode conducting an additional negative feed-back voltage is applied to grid 3 via resistor R17. These two negative voltages hold grid 3 negative and the left triode in the nonconducting condition.

3.43 When a start pulse is received via resistor R45 grid 3 becomes positive and the left triode starts to conduct. At this point, (1) plate 4 becomes negative as shown in Fig. 10(B), (2) this negative voltage drives grid 7 to cut off through capacitor C10 as shown in Fig. 10(D), (3) the cutoff voltage on capacitor C10 starts to leak off as shown by the slanting line in Fig. 10(D), (4) grid 7, cut off, causes the voltage on plate 6 to go positive as shown in Fig. 10(E).

3.44 The constants in the right-hand grid circuit are arranged so that the cutoff voltage from capacitor C10 will leak off through resistors R19 and R20. The time required for this leak off is adjusted, during the calibration procedure, to about 84 per cent of the character length. At this point, grid 7 becomes sufficiently positive to cause the right triode to conduct. Also at this point, the circuit returns to the condition described in Paragraph 3.42, causing a (—) to (+) transition on plate 4 as shown in Fig. 10(B) and a (+) to (—) transition on plate 6 as shown in Fig. 10(E). When the set

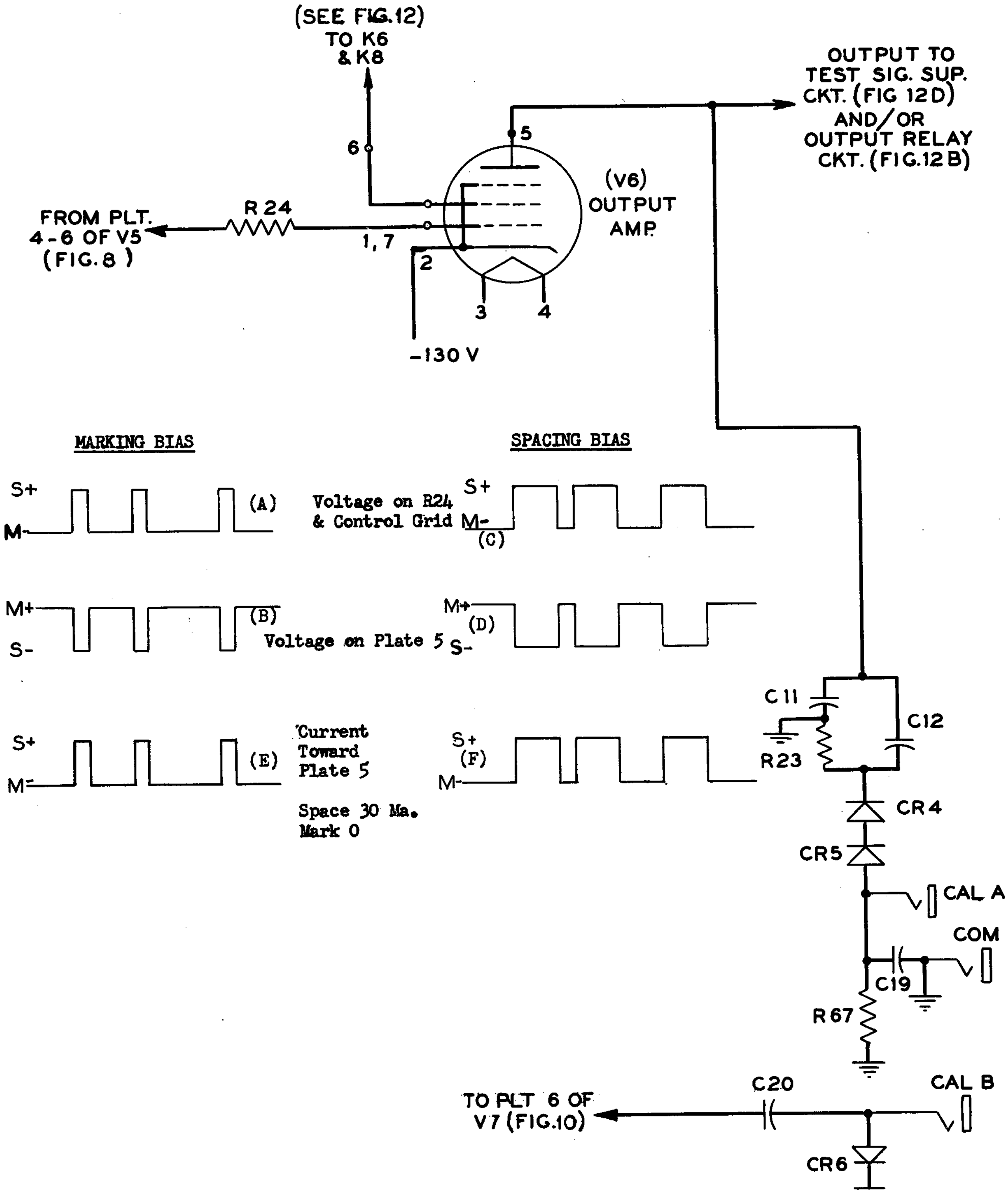


Fig. 9—Output Amplifier

is arranged for 6-unit code signals the leak off time of capacitor C10 is delayed an extra pulse length. This is accomplished automatically, by adding a small capacitor through the operated contacts of relay K14, when switch S6 on the control panel is operated to (6).

3.45 From the foregoing it may be seen that for every character transmitted there is a negative going transition on plate 4 at the beginning of the start pulse and a negative going transition on plate 6 near the middle of the stop pulse. These negative going transitions are used for switching the control voltages on the MD and SD control leads as will be described in the succeeding paragraphs.

First Count Circuit

3.46 The first count circuit, tube V8, is connected as a flip-flop circuit with plates and grids cross-connected through resistors R10 and R16. One triode of V8 conducts in all cases. When one triode conducts it automatically cuts off the other triode. When a negative pip (voltage swing) is applied to both grids simultaneously the tube will flip, or flop, so that the conducting triode becomes the nonconducting triode. The conducting triode produces a negative voltage on its associated MD or SD control lead, and the nonconducting triode produces a positive voltage on its associated MD or SD control lead. Tube V8 (1) reverses the MD and SD control lead voltages during every stop pulse in the switched bias condition, (2) reverses the MD and SD control lead voltages at the beginning of every start pulse in the switched end-distortion condition, (3) furnishes negative voltage swings to the second count circuit (V9) at the beginning of every other start pulse as explained later, and (4) with the right cathode open for marking bias holds the MD control lead positive and the SD control lead negative.

Switched Bias

3.47 In the switched bias condition relays K1 and K2 are released, relay K3 is operated, and plate 6 of V7 is connected through contacts 7-8 (K3) and 1-2 (K1) to capacitors C6 and C7 associated with tube V8. From Fig. 10(E) it may be seen that plate 6 of V7 delivers a negative going transition to capacitors C6 and C7 near the middle of every stop pulse. This negative going transition on capacitors C6 and C7 produces a negative pip (voltage swing) as shown in Fig. 10(F). This negative pip is applied simultaneously to grids 3 and 7 of V8 causing tube V8 to flip or flop, so that the nonconducting triode conducts. Tube V8, therefore, serves as an electronic switch swinging from one triode (conduction) to the other each time a negative pip is applied to both grids. This interchanging of conducting triodes reverses the polarity of the MD and SD control leads during the stop pulse of every character resulting in switched bias.

Switched End-Distortion

3.48 In the switched end-distortion condition relay K2 is operated, and relays K1 and K3 are released. Plate 4 of V7 is connected through contacts 8-9 (K3) and 1-2 (K1) to capacitors C6 and C7 associated with tube V8. The action of V8 in this case is the same as described for switched bias, except that the negative pips (voltage swings) occur at the beginning of the start pulse. Refer to Figs. 10(B) and 10(C). The interchanging of conducting triodes, in this case, reverses the polarity of the MD and SD control leads during the start pulse of every character resulting in switched end-distortion.

Marking Bias

3.49 Marking bias is produced by disabling the counting circuit and holding it in a steady state condition. In this condition relay K3 is released and relays K1 and K2 are operated. Relay K1, operated, separates the right and left cathodes of V8 and V9, and disconnects the character timer from the first count circuit. Relay K2, operated, connects —130V battery to the left cathodes of V8 and V9, leaving the right cathodes open. In this condition the left triodes of V8 and V9 remain conducting and the right triodes are, in effect, cut off. With the right triode of V8 cut off positive voltage from plate 6 may be traced to the MD control lead through transfer contacts 6-7 (K2). Likewise, with the left triode conducting negative voltage from plate 4 may be traced to the SD control lead through transfer contacts 3-4 (K2).

Note: It will be noted, by referring to Fig. 10, that when relay K2 is operated (for marking bias) there is no circuit path from the plates of tube V9 to the MD and SD control leads.

3.50 From the foregoing it may be seen that positive voltage is applied to the MD control lead and negative voltage is applied to the SD control lead from tube V8 during the marking bias condition of the set. Also, it may be seen that tube V9 serves no practical purpose in this case.

Second Count Circuit

3.51 The second count circuit, tube V9, is connected as a flip-flop circuit with plates and grids cross-connected through resistors R4 and R8. The flip-flop action of this tube is the same as that described for the first count circuit. Plate 4 of V8 is connected via capacitor C1 and resistor R2 to grid 3 of V9, and via capacitor C2 and resistor R7 to grid 7 of V9. Tube V9 will, therefore, flip or flop each time that tube V8 returns to its left triode conducting condition. Tube V8, as previously explained, returns to the left triode conducting condition on every other character. Tube V9 will, therefore, flip or flop on every other character.

Switched Combination Distortion

3.52 In the switched combination distortion condition relays K1, K2, and K3 are released. It will be noted, by referring to Fig. 10, that with these relays released there is no path from the plates of V8 to the MD and SD control leads; however, the flip-flop action of tube V8 is the same in this case as that described in Paragraph 3.46. Tube V9 will, therefore, receive a negative pip on its grids every time tube V8 returns to the left triode conducting condition which, as stated earlier, is on every other start pulse. When the left triode of V9 is conducting, (1) plate 4 is negative, (2) the right triode is cut off, and (3) plate 6 is positive. In this condition of V9 negative voltage may be traced from plate 4 through transfer contacts 3-2 (K3) and 4-5 (K2) to the SD control lead and positive voltage may be traced from plate 6 through transfer contacts 6-5 (K3) and 2-1 (K2) to the MD control lead. On the second start pulse received, tube V8 will flip to its right triode conducting condition and tube V9 will not be affected. On the third start pulse received, tube V8 will flop to its left triode conducting condition which, in turn, will flip tube V9 to the right triode conducting condition. When the right triode of V9 is conducting, plate 6 is negative cutting off the left triode making plate 4 positive. In this condition of V9 negative voltage may be traced from plate 6 through transfer contacts 6-5 (K3) and 2-1 (K2) to the MD control lead and positive voltage may be traced from plate 4 through transfer contacts 3-2 (K3) and 5-4 (K2) to the SD control lead.

3.53 From the foregoing it may be seen that switching occurs on every other start pulse, and a cycle of switched combination distortion is completed every four characters.

Spacing Bias

3.54 Spacing bias is produced by disabling the counting circuit and holding it in a steady state condition. In this condition relay K1 is operated and relays K2 and K3 are released. Relay K1, operated, separates the right and left cathodes of V8 and V9, and disconnects the character timer from the first count circuit. Relay K2, released, connects —130V battery to the right cathodes of V8 and V9, leaving the left cathodes open. In this condition the right triodes of V8 and V9 remain conducting and the left triodes, in effect, cut off. With the right triode of V9 conducting, negative voltage may be traced from plate 6 through transfer contacts 6-5 (K3) and 2-1 (K2) to the MD control lead and positive voltage may be traced from plate 4 through transfer contacts 3-2 (K3) and 5-4 (K2) to the SD control lead.

Note: It will be noted, by referring to Fig. 10, that when relay K2 is released (for spacing bias) there is no circuit path from the plates of tube V8 to the MD and SD control leads.

3.55 For a general review of the functions of the generating unit, reference may be made to Fig. 2 or Fig. 12 and the associated tables.

Calibration A

3.56 Distortion timing is calibrated by a method in which the timing resistance is set for a desired distortion of 100 per cent correspond-

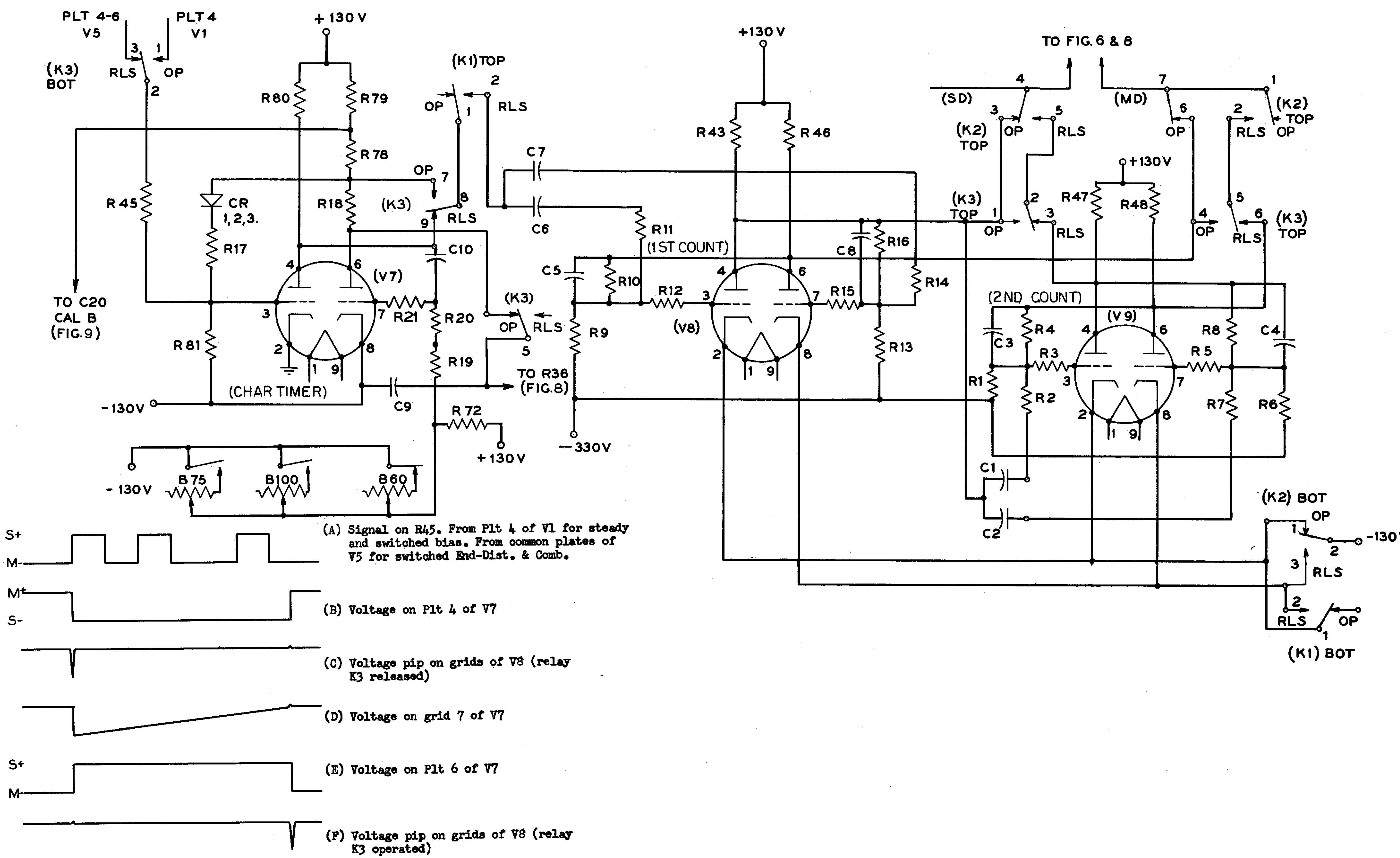


Fig. 10—Character Timing and Counting Circuits

ing to the CAL setting of control panel switches S1 and S2. The calibration adjustment is individual for the three operating speeds by selection of the proper A potentiometer under the control of the speed switch (S5) on the control panel. The A potentiometer settings are also correct for the corresponding 6-unit code signals when switch (S6) on the control panel is operated to 6.

3.57 The A potentiometers, associated with the right triode of V3, vary the delay time of tube V3 by varying the starting voltage on the charging capacitor shown as C in Fig. 7. The nominal starting voltage is —80V with a calibration adjustment over a range of about ±8V.

3.58 The effect of the calibration adjustment is observed in a circuit which is arranged to average the number of transitions over a period of time. The components making up this portion of the calibration circuit are shown in Figs. 9 and 12 as C11, C12, R23, CR4, CR5, C19, and R67. Capacitor C12 and resistor R23 have a time constant of about 0.2 millisecond. This portion of the circuit passes mark-to-space transitions as sharp negative voltage swings (pips), and space-to-mark transitions as sharp positive voltage swings to varistors CR4 and CR5. Varistors CR4 and CR5 are arranged for low impedance to negative pips (resulting from mark-to-space transitions) and high impedance to positive pips (resulting from space-to-mark transitions), thereby suppressing the positive pips and allowing only the negative pips to charge capacitor C19. Opposing this charging effect, of capacitor C19, is a discharge of capacitor C19 through leakage resistor R67. The net result of these opposing effects is the accumulation on capacitor C19 of a charge which is approximately proportional to the number of pips and hence approximately proportional to the number of mark-to-space transitions.

3.59 When the calibrating A potentiometers are set for slightly less than 100 per cent distortion (extreme counterclockwise position) all mark-to-space transitions are applied to capacitor C19 indicating a definite voltage. When the calibration adjustment increases the distortion to 100 per cent (rotation of A potentiometer clockwise) all single element spaces disappear and the average number of mark-to-space transitions applied to capacitor C19 are reduced to one half. This point may be accurately measured by observing the voltage at the CAL A and COM jacks. A more complete description is given in the following paragraphs.

3.60 The set is calibrated with miscellaneous signals; however, to illustrate the calibration of the timing circuit, reference is made to Fig. 11. In this illustration a teletypewriter H character has been used because it contains the average number of (four) transitions and a single element space. Fig. 11(B) represents the H character biased about 95 per cent marking. Fig. 11(C) indicates the voltage pips on capacitor C12 and R23 corresponding to the transitions. Fig. 11(D) indicates the voltage pips on capacitor C19 with slightly less than 100 per cent distortion. Fig. 11(E) represents the H character biased 100 per cent marking in which case the single space element (fourth selecting pulse) drops out. Fig. 11(F) indicates the voltage pips on capacitor C12 and resistor R23 with 100 per cent marking bias adjustment. Fig 11(G) indicates the voltage pips on capacitor C19 with 100 per cent marking bias adjustment.

3.61 From the foregoing and a comparison of Fig. 11(D) to 11(G), it may be seen that the correct calibration adjustment is indicated when the voltage measured at the CAL A and COM jacks drops to about half value.

Calibration B

3.62 This portion of the calibration adjustment arranges the set so that the timing of the character timer circuit V7 will be correct. This adjustment is made by operating the set with miscellaneous signals and varying the B potentiometers until a specific voltage is measured at the CAL B and COM jacks. The components making up this portion of the calibration circuit are shown in Fig. 12 as capacitor C20 and varistor CR6.

3.63 A portion of the voltage at plate 6 of V7 is coupled to the CAL B jack by capacitor C20. The CAL B jack is connected to ground through varistor CR6 which is so poled that the most positive potential which the CAL B jack can assume is only slightly above ground potential.

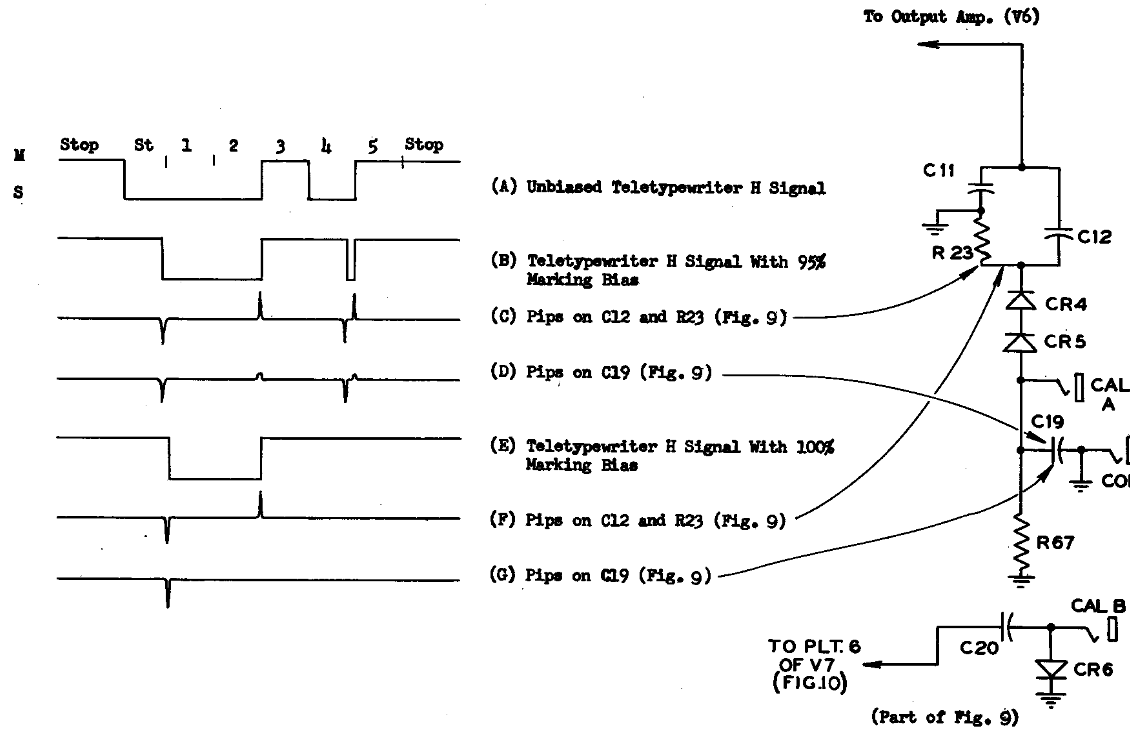


Fig. 11—Example of Calibration Voltages

3.64 It will be seen that when the driving potential from tube V7 is positive with respect to ground, capacitor C20 is charged to the driving potential. Thus, after a sufficient number of operations of tube V7, capacitor C20 becomes charged to the most positive potential of the driving point with respect to ground. After this has occurred, relatively negative swings of the driving point voltage appear at the CAL B jack, since the discharge path of capacitor C20 is through the high back-impedance of varistor CR6. Since the character timing is properly adjusted, plate 6 of V7 is cut off about 84 per cent of the character length (Paragraph 3.44), it follows that plate 6 is relatively negative only 16 per cent of the time. The average change in voltage at the driving point is 22.5V. The average calibrating voltage at the CAL B and COM jacks is, therefore, 3.5V.

3.65 As already described (Paragraph 3.44) the right triode of V7 starts conducting at a point corresponding to about 50 per cent of a unit interval inside the stop pulse. If this point were so adjusted that the right triode of V7 started conducting earlier, say at 45 per cent of a unit interval, and the generating unit were set for maximum distortion, the switching pulses from plate 6 of V7 would be generated ahead of the space-to-mark transitions at the beginning of the stop pulse in the generating unit. This, of course, would be undesirable and the CAL B adjustment provides for a margin of safety against such an occurrence.

(B) Output Relay Circuit

Testboard Office

3.66 This circuit converts the output of the generating unit to polar or effective polar signals, depending upon the method of terminating.

3.67 As has already been explained when the generating unit is in the marking condition output amplifier tube V6 is cut off and draws no plate current. Also when the generating unit is in the spacing condition output amplifier tube V6 draws current from the plate circuit and reduces the plate voltage.

3.68 When the output relay circuit receives a mark from the generating unit current flows from positive battery through resistors R98 and R99, through the windings of the SEND relay (K13) to ground. This current is sufficient in magnitude and of the proper direction to operate relay K13 to the marking contact. Refer to Fig. 12.

3.69 When the output relay circuit receives a space from the generating unit the drop in potential at the output of V6 is sufficient to reverse the direction of current flow through the windings of SEND relay, K13, and operate it to the spacing contact.

3.70 Signals from the armature of the SEND relay, K13, may be extended to a testboard or miscellaneous appearance circuit, to a TWX signal supply circuit, or to a concentrating unit test circuit. Refer to Fig. 12.

No. 1 Serviceboard Office

3.71 The output relay circuit provided at No. 1 serviceboard offices includes a switching arrangement so that inverse neutral test signals may be supplied to the serviceboard. This switching function is performed automatically by operation of the HB relay (K15) when connection is made to the 119C1 SIGS jack at the serviceboard. A simple schematic of the circuit is shown in Fig. 13. The schematic assumes that relay HB (not shown) is operated. When HB is so operated the SEND relay (K13) applies —48V for the mark and ground for the space. The inverse neutral operating currents are as shown in Fig. 13. In order to send test signals to a circuit under test, connection may be made as follows:

(a) To send test signals to a loop facility connect the SIG T cord SIGNAL to the 119C1 SIGS jack, and the SIG T cord LEG to the G jack of the 90-type loop repeater associated with the loop facility under test. Depress the ST SIG key momentarily to start the test signals.

(b) To send test signals to an idle regenerative repeater, (1) patch the idle regenerative repeater to the B jack of the REGEN TST CKT, (2) connect the SIG T cord SIGNAL to the 119C1 SIGS jack, (3) connect the SIG T cord LEG to the C jack of the REGEN TST CKT. Depress the ST SIG key momentarily to start the test signals.

3.72 When connection is made at an appearance other than at the serviceboard (such as a TWX testing position) the HB relay is released. With HB released the output relay circuit and its operation is as described for a testboard office.

(C) Testboard or Miscellaneous Appearance Circuit

3.73 This circuit provides switches, keys, and jacks for controlling the switching functions of the output relay circuit, and for connection to circuits under test. The control panel for this circuit is shown in Fig. 3(C), and a simple schematic is included in Fig. 12. A potentiometer ADJ LP CUR is provided for the adjustment of operating current when connection is made to the REG BIAS SIG jack. The ADJ LP CUR potentiometer is excluded from the circuit when connection is made to the TWX BIAS SIG jack. The SIG jacks may be extended to other miscellaneous appearances for convenient distribution of outlets. The 119C1 set is automatically started when connection is made to any SIG jack. A visual busy, or idle, indicating lamp is provided at each SIG jack appearance, except in cases where a given set serves only one test position. Switch S7 may be used to hold the output relay circuit in the steady marking or steady spacing condition for measurement of operating current and override. The output may be obtained as a polar signal by connecting the SIG jack to an external ground; or it may be obtained as an effective polar signal by connecting the SIG jack to an external battery. The REG BIAS SIG jack is patched to drop 1 of a TLT, with switch S8 operated to —M, to send signals toward drop 2, and is patched to drop 2 of a TLT, with switch S8 operated to +M, to send signals toward drop 1 of a TLT.

Testboard Appearance for TWX Signals Only with Control of Distortion at the Appearance

3.74 This circuit arrangement may be added to the output relay circuit for TWX signals only. With this arrangement, shown in Fig. 14, all signals appearing at the TWX BIAS SIGS jack are poled positive for a mark. By wiring options the signals may be ±130V or ±48V, but the polarity is not reversible. The circuit may be wired for control of distortion, by operation of the BIAS SIGS key, in one of two arrangements as follows:

	BIAS SIGS Key (Position) Arrow Left	Arrow Up	Arrow Right
Arrangement (1) (V Option)	Switched End-Distortion	Switched Combination Distortion	Switched Bias
Arrangement (2) (W Option)	Spacing Bias	Switched Combination Distortion	Marking Bias

(D) Test Signal Supply

No. 2 or 9B Serviceboard Office

3.75 The schematic drawing, Fig. 12(d) and (f), shows examples of the miscellaneous jack arrangement for obtaining test signals at the serviceboard positions.

No. 1 Serviceboard Office

3.76 The schematic drawing, Fig. 13, shows the arrangement for obtaining test signals at the serviceboard positions.

(E) Special Signal Input Arrangements

3.77 Special signal input arrangements are provided for the various types of offices so that test signals other than the standard test sentence may be used to drive the 119C1 set. In using the special input arrangements it is necessary to exercise care in the setting of the SPEED controls of the 119C1 set. When connection is made to the SPEC SIGS IN or 119C1 INPUT jacks the special input signals appear on all T leads at relay K14. It is therefore possible to obtain input signals from the special source with any setting of the SPEED key. If the SPEED key setting does not match the speed of the special signals the amount of distortion generated will not correspond to the per cent distortion indicated by the controls (S1 and S2).

3.78 With all of the special signal input arrangements the start relay (K8) of the 119C1 set is operated when connection is made to the SPEC SIGS IN or the 119C1 INPUT jack. Also, the switching relay transfers the input of the 119C1 set from the 110C1 multiple sender to the special source. The features of the special input arrangements which are different for the various types of offices are as follows:

Testboard Office

3.79 The special signal input arrangement for a testboard office is shown in Fig. 15. Open and closed signals operate relay CS by current flow as indicated in the figure. These open and close signals are converted to electronic output signals. When relay CS is on mark, tube H is cut off and draws no current from the hub potentiometer. With no current drawn from the hub potentiometer, the hub voltage applied to grid 3 of V1 is the +60V marking potential. When relay CS is on space, tube H conducts and draws 30 milliamperes from the hub potentiometer. This current drawn from the hub potentiometer drops the hub voltage applied to grid 3 of V1 to the —30V spacing potential.

No. 1 Serviceboard Office

3.80 The special signal input arrangement for a No. 1 serviceboard office is shown in Fig. 16. Inverse neutral signals operate relay SP by current flow as indicated in the figure. These inverse neutral signals are converted to electronic output signals which drive the 119C1 set in the same manner as described for a testboard office.

No. 2 Serviceboard Office

3.81 The special signal input arrangement for a No. 2 serviceboard office is shown in Fig. 17. When connection is made to the 119C1 INPUT jack, battery is applied to the sleeve of the jack which operates relay K3. Relay K3 operated, (1) operates the switching relay and transfers the input leads to the special circuit, (2) opens the H1 and HP connection, thereby lifting the hub potentiometer from the 119C1 input circuit, and (3) operates the start relay (K8) in the 119C1 set. Hub signals +60V mark and —30V space are then transmitted directly into the 119C1 input circuit.

No. 9B Serviceboard Office

3.82 The special signal input arrangement for a No. 9B serviceboard office is shown in Fig. 18. The circuit function is exactly as described for a No. 2 serviceboard, the only difference being that the various leads are switched by the springs of the jack and the relay (K3 of Fig. 17) is not required.

4. OPERATION

(A) Calibration

4.01 Apparatus

1—KS-14510, L1 Meter (Triplett 630-D) or equivalent (see Item 5)

1—Screwdriver

4.02 Procedure:

(1) Check that the 119C1 set is idle and that control switch S5 is set for the proper speed. Check that switch S6 is on 5.

(2) Operate switches S1 and S2 on the control panel to CAL.

(3) Operate switch S4 on the control panel to M BIAS.

(4) Start the set by patching a TTY, or by inserting a plug of the appropriate type, in any SIG jack appearance of the set.

(5) Remove the front cover from the generating unit. Connect the KS-14510 Meter to the COM and CAL A jacks (COM+) using the 3-volt dc scale or the lowest scale above 3V. If a KS-14510 Meter is not available, a Triplett 650 may be used.

(6) Adjust the appropriate A potentiometer (corresponding to speed) to the extreme counterclockwise position.

(7) Note the average voltage on the dc voltmeter over a period of about 10 seconds.

(8) Slowly adjust the A potentiometer in the clockwise direction until the average voltage indicated in item (7) suddenly drops to about half of its initial value. The point where the voltage just drops to half value is the correct adjustment of the A potentiometer.

(9) Operate switches S1 and S2 on the control panel to 0.

(10) Connect the voltmeter to the COM and CAL B jacks (COM+) using the 10-volt scale.

(11) Adjust the appropriate B potentiometer (corresponding to speed) for an average indication of 3.5 volts.

(12) Restore the set to normal.

4.03 The calibration should be repeated for each speed of signaling and should not be changed in the normal use of the set.

4.04 The set should be recalibrated when the performance indicates that the calibration is not correct.

Check of Calibration with 118-Type TMS

4.05 Procedure:

(1) Connect the output of the 119C1 set to the 118-type set in the usual manner.

(2) Arrange the 119C1 set controls as follows:

Switch	Setting
S1-S2	0
S4	M BIAS
S5	To match speed of signal source
S6	To match code of signal source (5 or 6)

(3) Note the total distortion and bias indicated on the TMS. The distortion should be 4 per cent or less, and the bias should be 2 per cent or less.

(4) Operate switch S4 to S BIAS. The distortion and bias measured on the TMS should be within 2 per cent of the indications noted in item (3).

Check of Calibration with Monitoring Teletypewriter

4.06 Procedure:

(1) Connect the output of the 119C1 set to the monitoring TTY in the usual manner.

(2) Arrange the 119C1 set controls as follows:

Switch	Setting
S1-S2	0
S4	M BIAS
S5	To match speed of signal source
S6	To match code of signal source (5 or 6)

(3) Compute the distortion and bias from orientation range measurements in the usual manner. The distortion should be 4 per cent or less, and the bias should be 2 per cent or less.

(4) Operate switch S4 to S BIAS. The distortion and bias should be within 2 per cent of that measured in item (3).

4.07 If the teletypewriter used in Paragraph 4.06 is not known to be free of internal bias, a rough check may be made as follows:

(a) Repeat items (1) and (2) of Paragraph 4.06.

(b) Check the upper range on the TTY.

(c) Operate switch S4 to S BIAS. Check the upper range on the TTY. The upper limit in items (b) and (c) should not differ by more than 2 per cent.

(B) Maintenance

4.08 The relays in the 119C1 set should be maintained in accordance with circuit requirement tables shown on Drawing SD-70641-013.

4.09 Maintenance work on the other parts of the set is indicated if difficulty is experienced in obtaining satisfactory calibration or performance. The electron tubes may be checked in a tube tester such as the Hickok Model 530B; however, such tests may not indicate the suitability of tubes for operation in this circuit. For this reason, and because tube testers may not be available in the smaller offices, it is suggested that tubes be replaced on a trouble basis.

4.10 A table of voltages at designated test points together with suggested trouble testing procedures are included in Fig. 19. The voltage requirements are based on the results of tests made on selected sets at various locations. While it is known that the set will operate satisfactorily on voltages falling outside of the specified limits, it is felt that the published figures will serve as a guide in locating troubles.

(C) Identification of Distortion by Types

4.11 In the event that it is desired to check the type of distortion generated in the 119C1 set special tests may be necessary. The procedure to be employed will depend upon the availability of testing apparatus suitable for the purpose.

4.12 It appears that the most satisfactory means of identifying the type of distortion being generated is with the 164C1 telegraph transmission measuring set. This is a portable cathode ray set capable of displaying any of the types of distortion that may be generated. Since this set may not be available alternate methods of identifying distortion by types are outlined below.

4.13 The 118-type telegraph transmission measuring set may be used to identify distortion by types. If the distortion is ***steady bias*** this will be indicated directly on the TOTAL DIST and BIAS meters. If the distortion is one of the three switched types, the magnitude of the distortion will be indicated by the TOTAL DIST meter; however, the BIAS meter in its attempt to follow the rapidly changing signs of distortion will average approximately zero. If switched distortion is thus indicated it may be further identified by making special observations as follows:

(a) Note the TOTAL DIST meter indication.

(b) Depress the S-M only key momentarily and note the TOTAL DIST meter indication.

(c) Depress the M-S only key momentarily and note the TOTAL DIST meter indication.

Analysis of Results

Switched bias is indicated if tests (a) and (b) give approximately the same TOTAL DIST indication and test (c) indicates near zero.

Switched end-distortion is indicated if tests (a) and (c) give approximately the same TOTAL DIST indication and test (b) indicates near zero.

Switched combination distortion is indicated if tests (a), (b), and (c) give approximately the same TOTAL DIST indication.

4.14 The X-75041 telegraph transmission measuring set may also be used to identify distortion by types. At least 10 per cent distortion should be generated when checked with this set. The suggested procedure is as follows:

(a) Operate the TRANSITION switch to the left (S-M only) and observe the position of the illuminated spots on the screen with respect to the zero axis.

(b) Operate the TRANSITION switch to the right (M-S only) and observe the position of the illuminated spots on the screen with respect to the zero axis.

Analysis of Results

(1) Spacing bias is indicated if the spots on the screen are displaced to the left of the zero axis in test (a) and appear near the zero axis in test (b).

(2) Marking bias is indicated if the spots on the screen are displaced to the right of the zero axis in test (a) and appear near the zero axis in test (b).

(3) Switched bias is indicated if the spots on the screen alternate between conditions (1) and (2) in test (a) and appear near the zero axis in test (b).

(4) Switched end-distortion is indicated if the spots on the screen alternate between conditions (1) and (2) in test (b) and appear near the zero axis in test (a).

(5) Switched combination distortion is indicated if the spots on the screen alternate between conditions (1) and (2) in both tests (a) and (b).

4.15 A monitoring teletypewriter or a 1-A teletypewriter test set may be used to a limited extent in identifying the types of distortion generated. While it is possible to distinguish between steady bias and switched distortion, it is impractical to distinguish the various types of switched distortion one from the other.

4.16 In offices having 119C1 sets where testing apparatus is inadequate for making the desired tests, the output signals may be trunked over a good transmission circuit to an adjacent office for assistance in making the tests and analyzing the results.

5. DESCRIPTION OF EQUIPMENT

5.01 The generating unit occupies the space of four 1-3/4-inch by 19-inch mounting plates in the serviceboard or testboard position. It is provided with removable covers front and rear. The generating unit should be located within 15 feet of the associated control panel, and the leads between the two units run in a separate cable.

5.02 The output relay unit occupies the space of two 1-3/4-inch by 19-inch mounting plates. The unit is generally located on a relay rack separate from the serviceboard or testboard position, but should be located within 500 feet of the associated generating unit.

5.03 The control panels occupy a space of two 1-3/4-inch by 19-inch mounting plates for each panel. The control panel equipment is usually located near the generating unit in a serviceboard or testboard position.

5.04 The electron tubes used in the generating unit are listed in Fig. 2 together with a brief summary of their respective functions.

6. REFERENCE DRAWINGS

(A) Circuits

119C1 Telegraph Signal Distorting Set	SD-70641-011 -012 -013
Negative 330V Bias Supply and Distribution Ckt.	SD-70627-01
No. 2 or 9B Serviceboard—Test Signal Supply	SD-70592-01
TTY Line Concentration Unit No. 101, Test Circuit	SD-70062-011
TTY Line Concentration Unit Nos. 101A and 102A, Test Circuits	SD-70295-011
110C1 Multiple Sender	SD-70206-011

No. 1 Serviceboard—Test Signal Supply	SD-70177-011 -012 -013

(B) Equipment

119C1 Telegraph Signal Distorting Set Generating Unit Equipment	ED-71029-01
119C1 Telegraph Signal Distorting Set Output Relay Unit Equipment	ED-71036-01
119C1 Telegraph Signal Distorting Set Control Panel Equipment (Serviceboard)	ED-71037-01
119C1 Telegraph Signal Distorting Set Control Panel Equipment (Testboard)	ED-71139-01
119C1 Telegraph Signal Distorting Set Control Panel Equipment (Miscellaneous Appearance)	ED-71139-012
Negative 330V Rectifier Panel Equipment	ED-71040-01

Summary of Functions of Signal Distorting Set

Functions Obtained	Control Pan. Keys Operated	Relays Involved	Char. Tmr. Start Sig. Source	Count Pulse From	Switching Instant	Switching Cont. By
*Marking Bias	All Normal	K1, 2 Op K3 Rls				
*Spacing Bias	S4(S-BIAS)	K1 Op K2, 3 Rls				
*Switched Bias	S3(BIAS) S4(SW DIST)	K1, 2 Rls K3 Op	Plt 4 (V1)	Plt 6 (V7)	Every Stop Pulse	V8
*Switched End-Dist	S4(SW DIST)	K1, 3 Rls K2 Op	Plt 4-6 (V5)	Plt 4 (V7)	Every Start Pulse	V8
*Switched Comb. Dist.	S3(COMB) S4(SW DIST)	K1, 2, 3 Rls	Plt 4-6 (V5)	Plt 4 (V7-8)	Every 2nd Start Pulse	V9
100 Speed	S5(100)	K6 Rls, K7 Op				
75 Speed	S5(75)	K6 Op, K7 Rls				
60 Speed	(Normal)	K6, 7 Rls				
**25% Dist.		K4, Op, K5 Rls				
**30% Dist.		K4 Rls, K5 Op				
**35% Dist.		K4, 5 Op.				
Dial Control of Dist.		K4, 5 Rls				
Batt. On		K8 Op (Plug in any SIG jack)				
6-Unit Code	S6(6)	K14 Op				

*Signals in 5-Unit Code at 60-speed. Key S3 is not effective except when S4 is on SW DIST.

**Control equipment for selecting 25%, 30% and 35% distortion remotely is not normally provided. Relays K4 and K5 are normally released. Fig. 12 shows the circuit with K4 and K5 released and the relays are omitted.

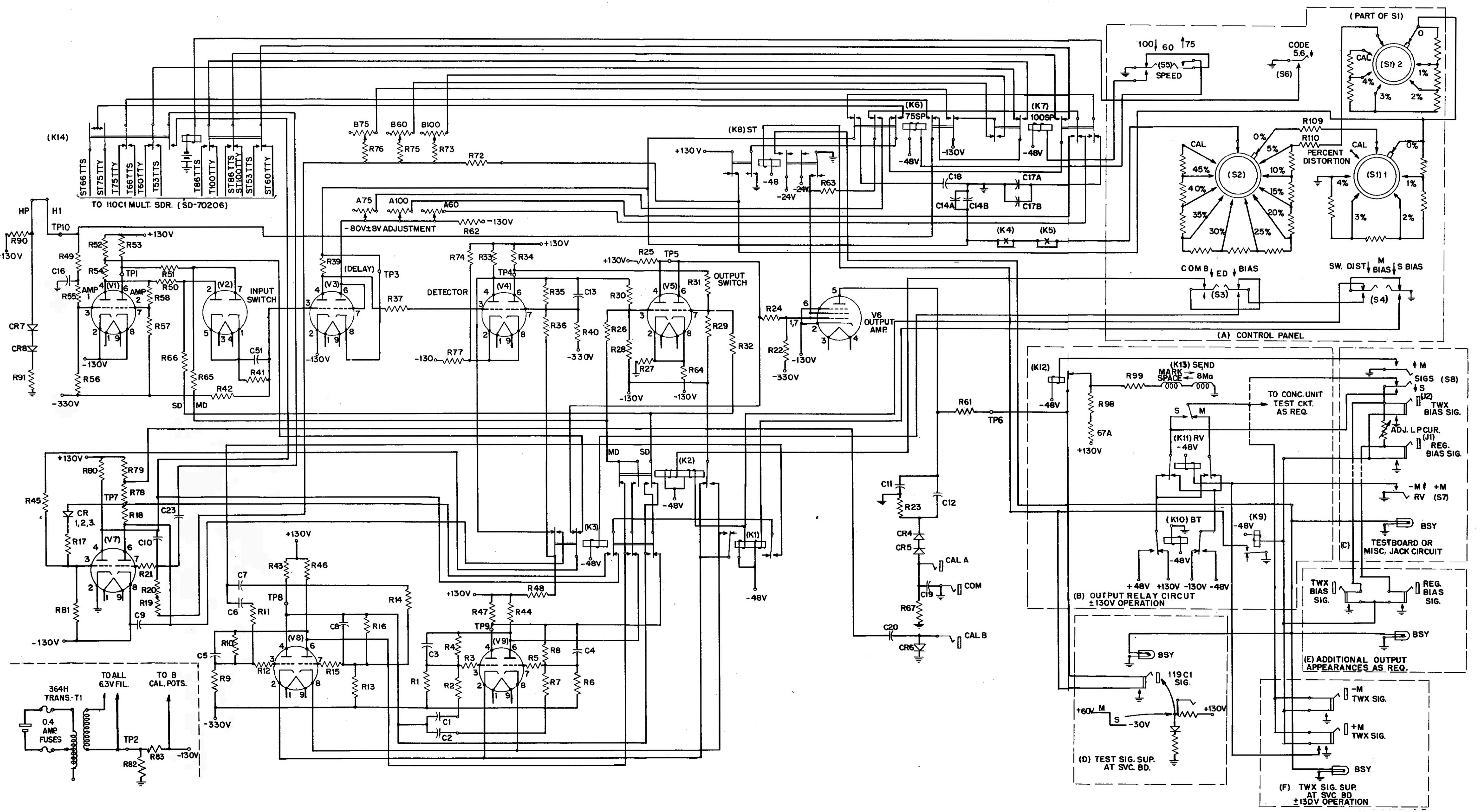
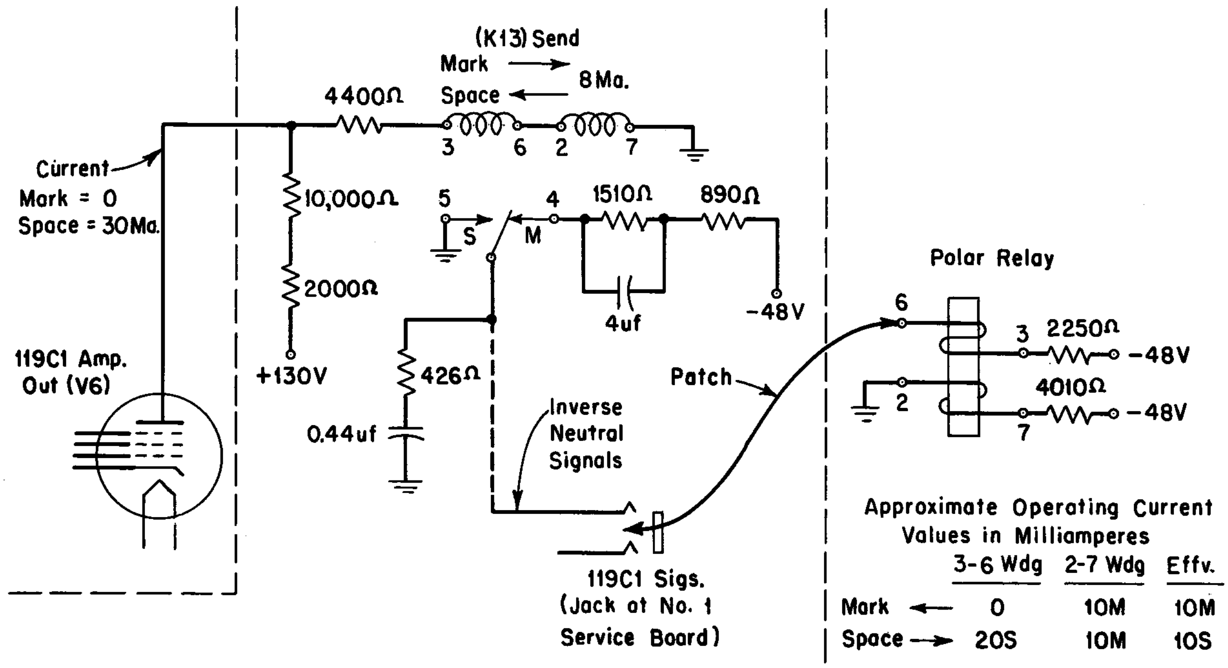


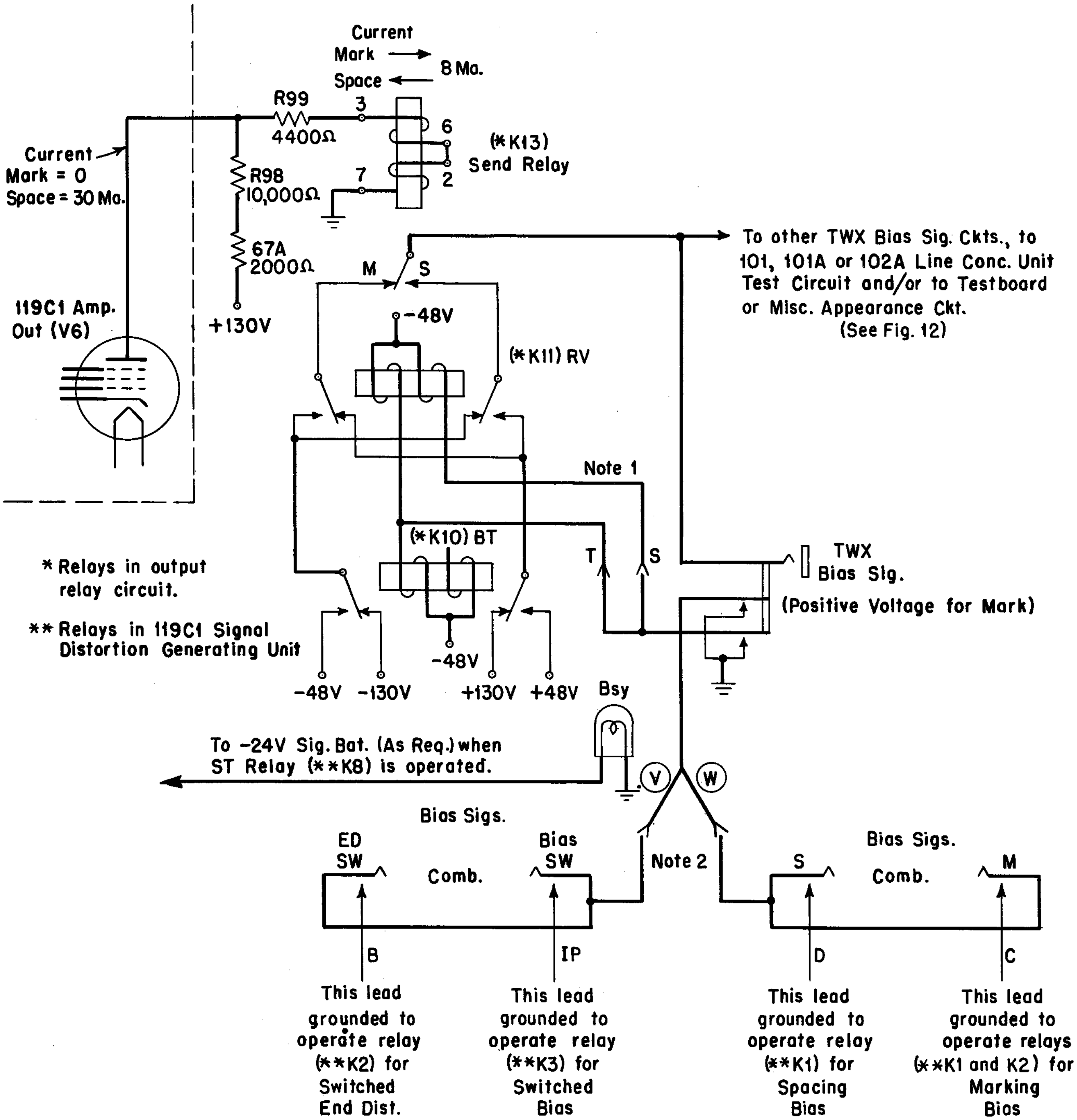
Fig. 12—Circuit Schematic of 119C1 Telegraph Signal Distorting Set



	3-6 Wdg	2-7 Wdg	Effv.
Mark ←	0	10M	10M
Space →	20S	10M	10S

Note – This Simplified Schematic assumes that connection is made to the 119C1 Sigs Jack and the HB relay (K15) of the output relay circuit is operated. When relay HB (K15) is released the output relay circuit is as shown in Fig. 12.

Fig. 13—Example of Output Relay Circuit Arrangements for Inverse Neutral Signals—No. 1 Serviceboard



Note 1 - Use T wiring for ±130V signals. Use S wiring for ±48V signals.

Note 2- Use V wiring for Switched End-Distortion, Switched Combination Distortion and Switched Bias. Use W wiring for Steady Spacing Bias, Switched Combination Distortion and Steady Marking Bias.

Fig. 14—Testboard Appearance for TWX Signals Only with Control of Distortion at the Appearance

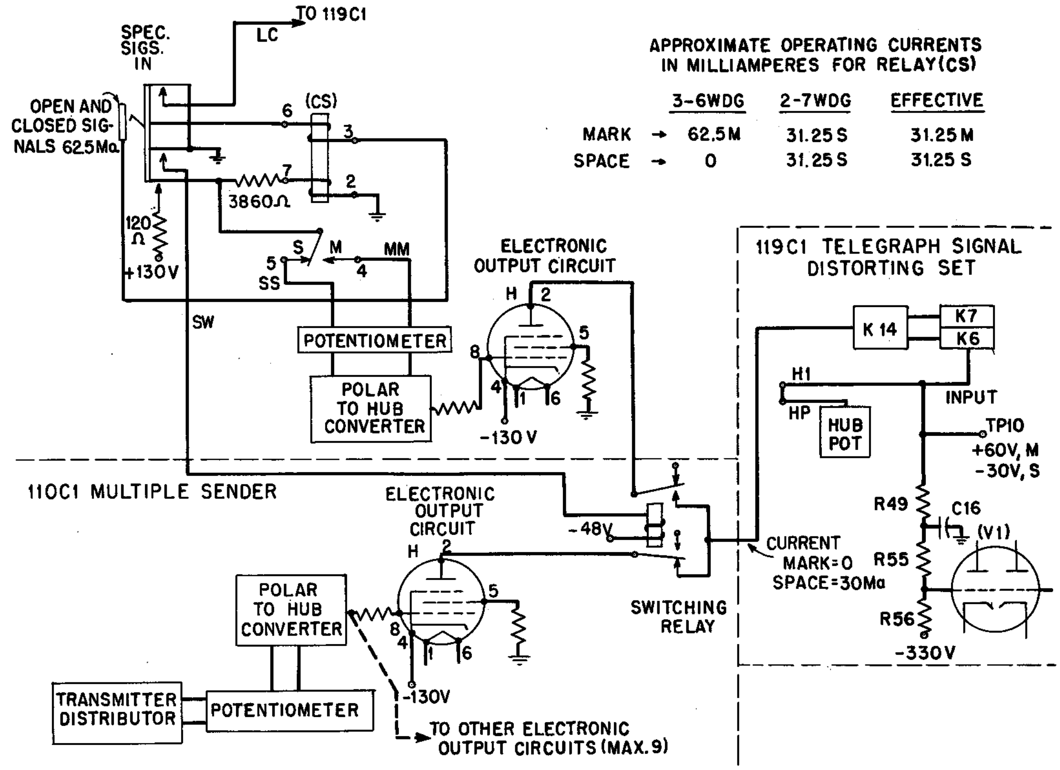


Fig. 15—Special Signal Input Arrangement—Testboard Office

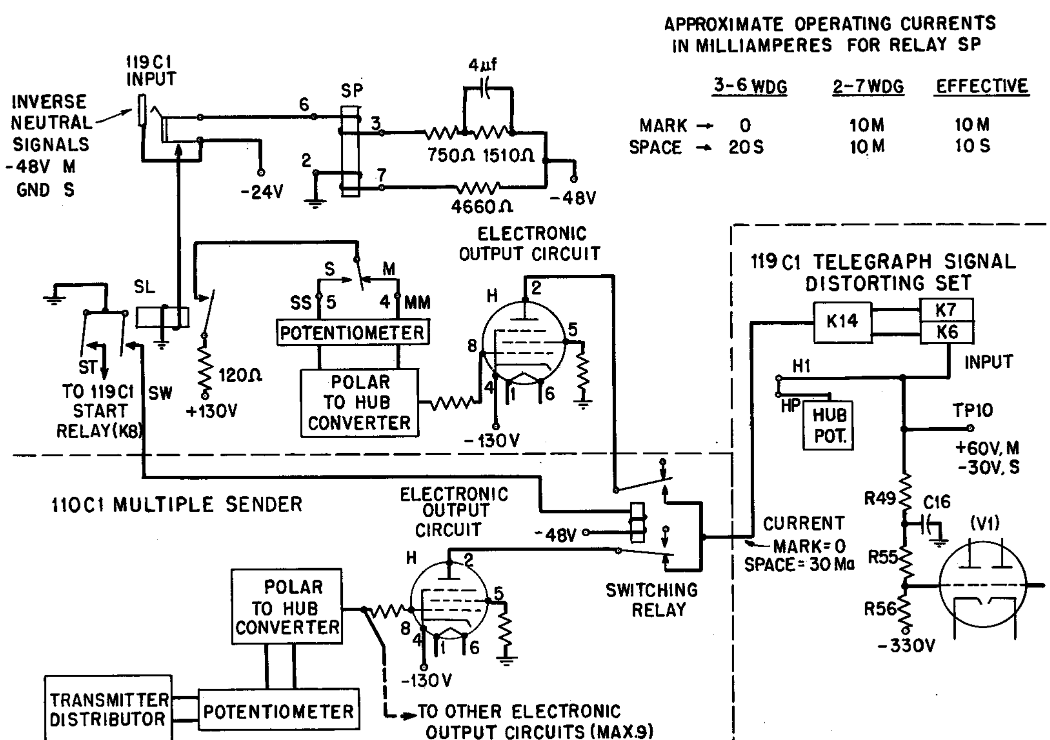


Fig. 16—Special Signal Input Arrangement—No. 1 Serviceboard Office

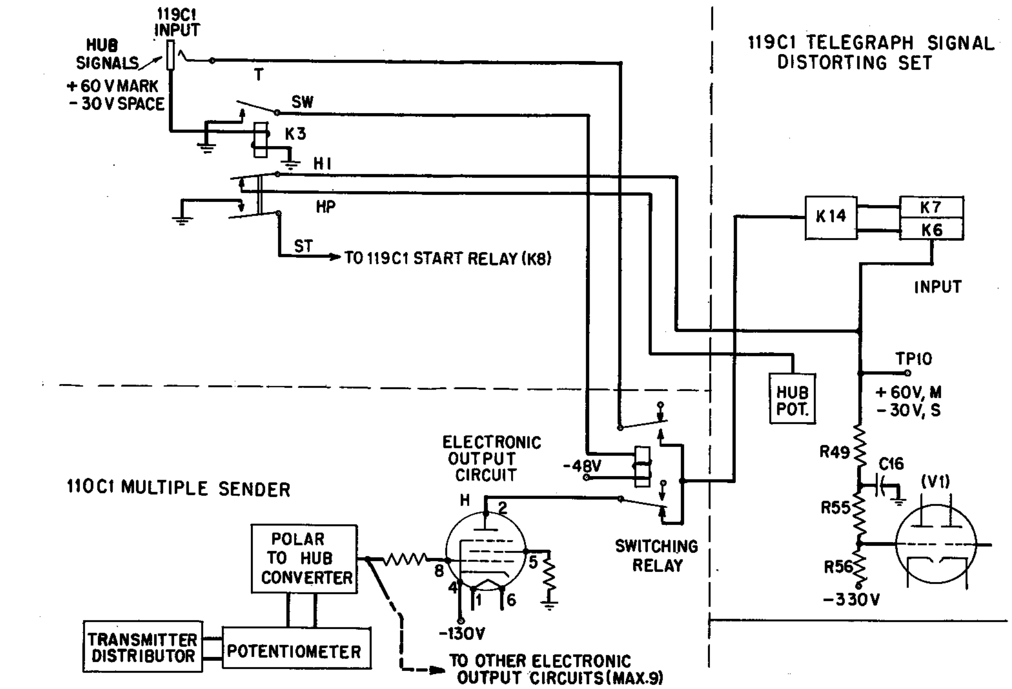


Fig. 17—Special Signal Input Arrangement—No. 2 Serviceboard Office

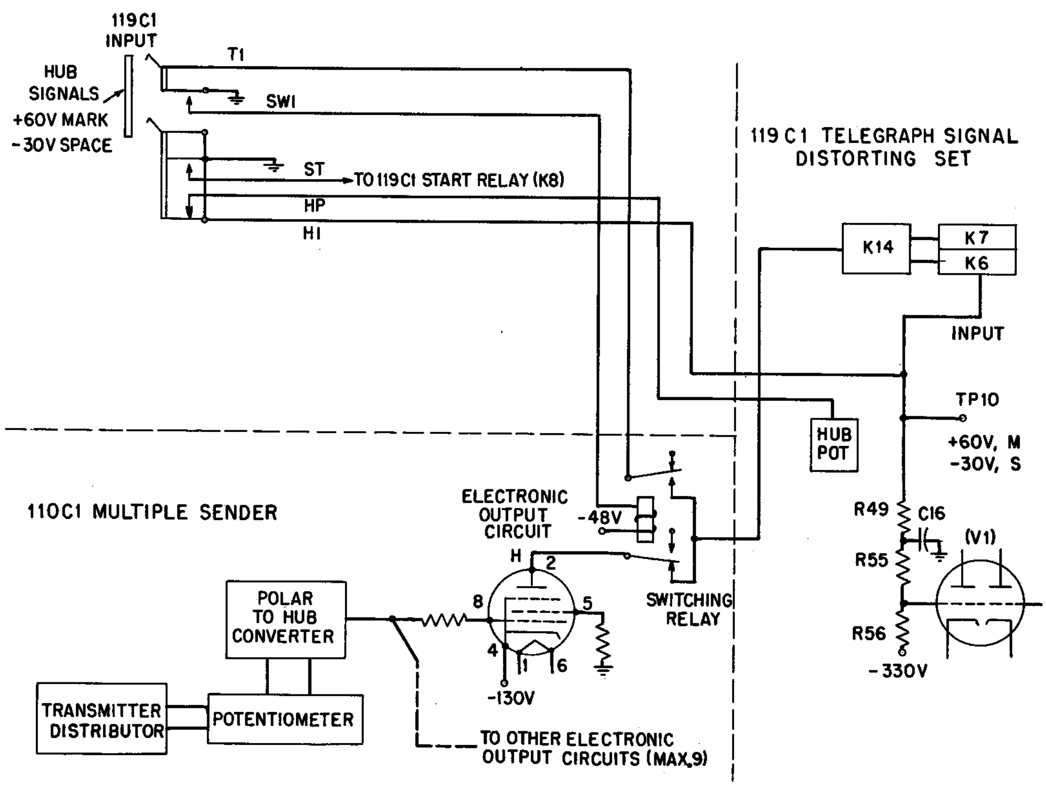
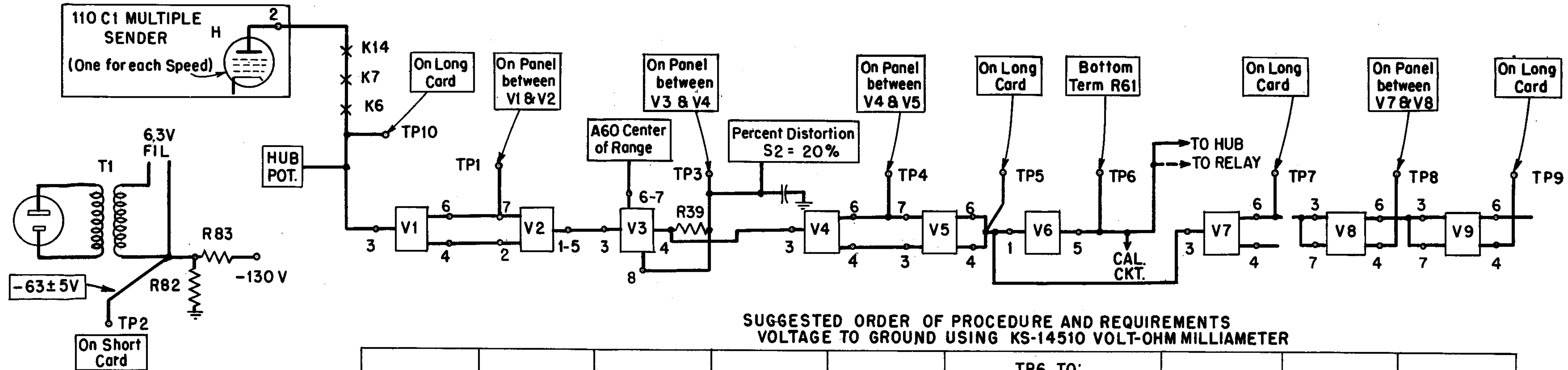


Fig. 18—Special Signal Input Arrangement—No. 9B Serviceboard Office



SUGGESTED ORDER OF PROCEDURE AND REQUIREMENTS
VOLTAGE TO GROUND USING KS-14510 VOLT-OHM MILLIAMETER

	TP10	TP1	TP3	TP4	TP5	TP6 TO: HUB	TP6 TO: RELAY	TP7	TP8	TP9
INPUT MARK →	+60 ± 10V	+120 ± 15V	-80 ± 10V	+30 ± 12 V	+12 ± 10V	+60 ± 5V	+40 ± 10V	-35 ± 20V	-90 ± 20V	-90 ± 20V
INPUT SPACE →	-30 ± 5V	-90 ± 20V	+30 ± 10V	+120 ± 15V	+110 ± 5V	-30 ± 5V	-45 ± 10V	OPR KEY 4 TO S-BIAS →	+110 ± 20V	+100 ± 15V

SUGGESTED PROCEDURE FOR LOCATING TROUBLES INDICATED BY VOLTAGE MEASUREMENTS

(1) - TP 2
- Not Ok → Check R82, R83 and -130V Supply

(2) - TP 10 - MARK
- Not Ok → Open the input to 119C1 by removing Tube H (119C1 M-S)
  - Not Ok → Check for trouble in HUB POT or other circuit components associated with the 2-3-4 triode of 119C1 Tube V1
  - Ok → Check for trouble in 110C1 M-S such as a defective output tube (Tube H) or trouble which would cause Tube H to conduct on MARK

(3) - TP 10 - SPACE
- Not Ok → Open the input as for MARK. Apply -130V at terminal 2 of Tube H socket (See below)
  - Not Ok → Check for trouble in HUB POT or other circuit components associated with the 2-3-4 triode of 119C1 Tube V1
  - Ok → Check for trouble in 110C1 M-S such as a defective output tube (Tube H) or trouble which would cause Tube H to conduct on MARK

(4) - TP 1, 3, 4, 5
- TP 1&3 Not Ok - Replace V1 and if necessary V2 & V3
- TP 3&4 Not Ok - Replace V2 and if necessary V3 & V4
- TP 4&5 Not Ok - Replace V4 and if necessary V5

(5) - TP 7
- Not Ok → Replace V7

(6) - TP 8 & 9
- Make two measurements with MARK input - (1) Key 4 on M-Bias (2) Key 4 on S-Bias
  - Not Ok → Replace V8 and/or V9

(7) - TP 6
- Not Ok → Remove V6 and recheck TP 6 on MARK input
  - Ok → Replace V6 and/or check for trouble in 119C1 set which would cause V6 to conduct on a marking input signal
  - Not Ok
    - Hub Office → Check for trouble in the hub circuit terminating the 119C1 output
    - Relay Office → Check for trouble in the output relay ckt. incl. +130V battery, 67A, R98 and R99
- Ok → Calibrate 119C1 → Make Transmission Tests
  - If 119C1 generates steady bias and fails to generate switched bias, tube V1 or V7 may be the cause.
  - If 119C1 generates switched bias and fails to generate switched E-D, tube V5 may be the cause.
  - If 119C1 fails on switched combination only, tube V8 or V9 may be the cause

SUGGESTED METHOD OF OBTAINING MARK AND SPACE INPUT SIGNAL FOR VOLTAGE TEST

110C1 MULTIPLE-SENDER CAN BE RELEASED

MARK - Turn off M-S and turn distributor by hand, in normal direction of rotation, until the brushes rest on the STOP segment.

SPACE - Turn off M-S and turn distributor by hand, in normal direction of rotation, until the brushes rest on the START segment.

110C1 MULTIPLE-SENDER CANNOT BE RELEASED

MARK - Locate Tube H in the 110C1 M-S which drives the 119C1 at the speed under test (60-speed in this case) and remove this tube from its socket.

SPACE - Apply -130V (through a suitable fuse) to terminal 2 of the socket of Tube H removed for the MARK.

Note - If special signal input arrangements are provided the above procedure is not necessary

SUGGESTED ARRANGEMENT OF OUTPUT CIRCUIT FOR VOLTAGE TEST

(1) For type 2 hub office - connect the TTY cord to the 119C1 SIGS jack.

(2) For No. 1 serviceboard office - connect SIG T cord SIGNAL to 119C1 SIGS jack.

(3) For testboard office - connect REG BIAS SIGS jack to a TLT in the normal manner.

Note - As an alternative for (2) and (3) block relays K9 and K12, of the output relay circuit, one operated and the other released.

SUGGESTED SETTING OF CONTROLS FOR VOLTAGE TEST

(1) Set all lever type keys, S3, S4, S5, S6, to the normal (center) position. Note - Key 4 is operated to S-Bias so that TP 8 & 9 may be measured in both positions of Key 4 on a MARK.

(2) Set per cent distortion (Switch S2) for 20%. As an alternative, block relay K4 operated and K5 released.

(3) Set A60 and B60 potentiometers (on front of panel) to mid-range. Note- if the set has previously operated satisfactorily the last CAL settings should be satisfactory for this test.

Fig. 19—Outline of Maintenance Procedures for 119C1 Telegraph Signal Distorting Set